ALBERTA'S CLEAN AIR ACT

CONCLUSIONS AND RECOMMENDATIONS OF THE REVIEW OF THE CLEAN AIR ACT

Report of the Environment Council of Alberta
to the Minister of the Environment

REVIEW OF THE CLEAN AIR ACT

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REPORT TO THE MINISTER

This report presents the main findings and recommendations of the Environment Council's review of the Clean Air Act (RSA 1980, chapter C-12), its associated regulations, policies and related programs. It is based upon a staff report written by ECA staff. The second section of this publication comprises that report.

THE PURPOSE OF THE AIR QUALITY MANAGEMENT PROGRAM

Ambient air quality standards form the cornerstone of Alberta's air quality management program. All associated management programs are designed to ultimately protect ambient air quality. The process by which air quality standards are set was examined by Franson *et al.* (1982). The first requirement is to have a clear goal for the air quality management program. For example, is our goal for air quality the protection of human health or some aesthetic objective? Do we intend to manage our air quality to protect other elements of Alberta's environment, such as plant life or soils? Alberta Environment does have a general goal; promoting a balance among resource management, environmental protection and the quality of life. The Department's Pollution Prevention and Control program is intended to prevent and control pollution in order to protect the environment and our quality of life (Alberta Environment 1977). An explicit goal for the management of air quality is needed to give clear direction to the standard-setting and enforcement programs. Identifying this goal for air quality management is not exclusively, or even mainly, a technical matter but should satisfy the needs and desires of Albertans. The Department should seek public consultation during the formulation of such a goal not only to assist in standard definition but to facilitate public acceptance of the standards developed.

- **Recommendation 1**

An explicit goal for air quality management should be developed with public input.

SETTING AMBIENT STANDARDS

Given a clear, publicly-supported goal, specific targets or standards for contaminants in the ambient air can be established. Most of Alberta's ambient standards are set out in the Clean Air (Maximum Levels) Regulation (AR 218/75) with others described in various guidelines, directives and reports. Several of the standards in the Maximum Levels Regulation were adapted from the National Air Quality Objectives which were developed by a subcommittee of the Federal-Provincial Committee on Air Pollution. The scientific criteria on which these objectives are based have been published by the federal government (Fisheries and Environment Canada 1976). For other standards in the regulation and for many of the guidelines used by the Department, no criteria have been published. A single document bringing together all of Alberta's ambient air quality standards and the criteria on which they are based would be very useful for government administrators, industry and the general public.

- **Recommendation 2**

Alberta Environment should publish a single document containing all of Alberta's ambient air quality standards and their associated criteria.

Setting ambient standards is not entirely a technical matter. In view of the paucity of conclusive research on health and environmental effects of air contaminants, a considerable amount of judgement is needed to assess the risks and to select the most appropriate standards. The public should be consulted to assist the government in making these difficult decisions. This would also increase public awareness and support for these standards.

- **Recommendation 3**

Provisions should be made to allow public input during the development of ambient air quality standards.

INDUSTRIAL EMISSIONS

By setting ambient air quality standards, we acknowledge that there is a limit to the amount of air pollution that our society will tolerate. This in turn limits our capacity for industrial development since some industrial emissions can degrade ambient air quality. The current strategy for controlling industrial air contaminants is to reduce the quantity of emissions as much as practicable and then dilute the residual. Emission stacks are designed to have sufficient height to adequately disperse the air contaminants and to keep ground-level concentrations below the ambient standards.

The Department has a policy favouring the use of the environment's capacity to assimilate industrial emissions. "Assimilation" refers to the incorporation of materials into biological systems. The capacity of the atmosphere to dilute contaminants is substantial, but its assimilative capacity is very limited. Most air contaminants are simply diluted and dispersed over long distances. Although the impact of these contaminants on the environment is difficult to measure, it is important to recognise that they are not primarily assimilated and rendered innocuous, but contribute to the degradation of environmental quality by small amounts over widely dispersed areas.

The Department views the assimilative capacity as a resource to be utilized. This suggests that where the "assimilative capacity" is perceived to be under-utilized, increased emissions from industrial facilities could be equally acceptable to treatment to high standards. Every increase in emissions, however, reduces our ability to accommodate future industrial growth, unless future technology is capable of reducing or eliminating industrial emissions in line with declining assimilative capacity. The Department should shift its focus from the utilization of the assimilative capacity to its protection and preservation.

- **Recommendation 4**

Alberta Environment should reassess its policy regarding the utilization of the "assimilative capacity" of the environment for waste disposal.

SETTING EMISSIONS STANDARDS

The federal government has established National Emission Standards for certain air contaminants from several Canadian industries. The Alberta government has also included emission standards in the Clean Air (Maximum Levels) Regulation. In addition, Alberta

Environment has developed emission guidelines for several industries and incorporates these into permits and licences issued to companies under the Clean Air Act. Setting emission standards is largely a technical matter. If the public has had sufficient input in setting the goal for air quality management and in setting ambient standards, public input to emission standards is not necessary.

Emission standards are usually based upon "best practicable technology." However, for certain especially harmful contaminants, such as lead and vinyl chloride, "best available technology" is used. To determine which technology is "best practicable" or "best available" a government-industry task force is used. The emissions associated with the chosen technology are used by Alberta Environment in establishing regulations for the industry.

The use of technology-based emission standards has certain disadvantages from the point of view of pollution control. In such a system, emission standards are tailored to the technology, rather than the technology being tailored to meet emission standards. There is little incentive for industry to seek methods of improving pollution control beyond existing requirements. The introduction of economic incentives, such as emissions charges or special taxes, would encourage industry to improve their performance, and switch their objective from meeting the requirements and regulations at the lowest cost to reducing levels of emissions at least cost.

- **Recommendation 5**

The use of economic mechanisms to encourage industry to limit emissions should be examined and, for a selected industry, a pilot project should be mounted to test the operational feasibility of economic controls.

REGULATING INDUSTRY

The Clean Air Act provides the means for implementing the standards and guidelines developed by government. Permits are required to construct industrial facilities and licences are required to operate them. Conditions may be attached to these permits and licences that prescribe aspects of project design, emissions limits, monitoring requirements and reporting procedures.

The Clean Air Act, its regulations and associated guidelines and policies provide for a wide variety of exemptions. For example, many of Alberta's emission standards do not apply during start-up, shut-down, equipment malfunction and emergency conditions. Not all industrial facilities are required to obtain permits or licences. In addition, certificates of variance can be issued to waive regulations or licence requirements. Considerable discretion is given to Department officials in applying some of these exemptions. However, there is insufficient direction in the legislation regarding the application of this discretion. An approved set of policies or guidelines is needed to clarify the application of this discretion.

- **Recommendation 6**

Guidelines for the application of administrative discretion in allowing exemptions from emissions standards should be developed to clarify this aspect of regulation for Department administrators, regulated industry and the interested public.

MONITORING AIR QUALITY

Another important component of Alberta Environment's air quality management program is the monitoring of air quality. It is important to monitor ambient air quality to ensure that acceptable air quality is being maintained. It is also necessary to monitor industrial emissions to ensure that regulations and licence conditions are being met.

In Edmonton and Calgary, the Department operates an extensive ambient air quality monitoring network with several contaminants monitored continuously and others on a cumulative basis. Public awareness of this monitoring effort is not very great. The annual monitoring reports should receive greater distribution to acquaint the public with this activity of the Department and the quality of the ambient air. The twice-daily air quality index (IQUA) is also underutilised by the public and the media. The phone number for the IQUA is not even listed in city telephone books. The IQUA should be promoted further.

- **Recommendation 7**

An effort should be made to promote public awareness of the Department's urban air quality monitoring activities.

Fort McMurray and Fort Saskatchewan also have continuous monitoring stations. Other major centres, such as Lethbridge, Medicine Hat and Red Deer, are monitored occasionally with mobile monitoring trailers. These monitoring episodes are not part of a planned long-term monitoring program, but are usually performed in response to special requests or problems. A regular monitoring program is warranted in these communities.

- **Recommendation 8**

A more comprehensive air quality monitoring program for larger urban communities, such as Lethbridge, Medicine Hat and Red Deer, should be examined. The particular needs of smaller communities with unique industrial emission problems should be considered. This might include communities like Hinton, Bonnyville, or Rocky Mountain House where a seasonal cycle of air monitoring could be undertaken every few years, or at stages in their industrial development.

Monitoring of industrial emissions is performed primarily by the companies themselves. Companies report their emission levels to the Department with explanations for contraventions that may have occurred. It is very important to ensure that company monitoring data are credible and accurate. To this end, the Department has issued several Air Monitoring Directives that specify detailed requirements for monitoring and reporting. A Performance Code has been issued for manual stack surveys and a code for continuous monitoring is currently being developed by the Department. The Department also conducts a quality assurance program that includes witnessing of manual stack surveys, inspecting instrument calibration, and several other activities. Recent public skepticism concerning industry self-monitoring may be reduced by publicizing the quality assurance program.

- **Recommendation 9**

The Department's quality assurance program for company monitoring data should be *re-evaluated to determine its adequacy. Steps should be taken to inform the public about this program.*

ENFORCEMENT

The information derived from air quality monitoring allows the Department to react to air quality problems. With respect to industrial emissions, contraventions of licensed or legislated emission limits require some form of government action. A wide selection of enforcement tools are available including technical discussions, air quality directives, emission control orders and stop orders. Prosecution is also available. The Department currently favours negotiating compliance over a more adversarial approach to enforcement. Although this policy has certain advantages, the willingness to prosecute must be clearly established in order to provide the Department with adequate leverage in the negotiation process. A further incentive to pursue prosecutions is to develop a greater familiarity with the legal provisions in the Clean Air Act and associated regulations and to identify any weaknesses in this legislation.

- **Recommendation 10**

The Department should examine its policy favouring negotiation of compliance to ensure that the willingness to prosecute is clearly established as an option in both the industry and public mind.

OTHER SOURCES OF AIR POLLUTION

Although the Clean Air Act and associated regulations provide an adequate basis for regulating industrial emissions, other sources of air pollution need to be addressed. These sources of pollution can also restrict ability to absorb future growth and development while maintaining high standards of air quality. In Calgary and Edmonton, automobile emissions contribute substantially to urban air pollution. Although automobile emission standards are set by the federal government, additional action is needed, in the area of public education, better maintenance of automobiles and the potential for carpooling and the use of public transit.

- **Recommendation 11**

Alberta Environment should investigate how sources of air pollution not regulated by the Clean Air Act should be reduced.

RESEARCH

Scientific research into the effects of air contaminants on health and the environment is limited. Furthermore, not all such research conducted elsewhere is relevant to the Alberta situation. Such information is necessary in determining appropriate standards for ambient air quality. In addition, exceedances of certain ambient air quality standards occur with regularity in some Alberta communities. Research into the causes of these contraventions and the actual effects on health or the environment are warranted. The Alberta government has already funded some relevant research through the Environmental Research Trust, Alberta Environmental Centre and the Department's Research

Management Division. Support for this kind of research should be continued. The current Acid Deposition Research Programme is an excellent example of this approach.

- **Recommendation 12**

The Provincial Government should encourage and support further research into health and environmental effects of air contaminants in Alberta.

CONCLUSION

Although the Clean Air Act and its associated regulations, guidelines and policies constitute a reasonably tough stand against air pollution, the Environment Council has identified several areas where improvements could be made. Weaknesses were found in some of the fundamental components of the air quality management program; no explicit goal for air quality management and inadequate opportunity for public input to ambient air quality standards. Other suggestions are made to improve public awareness of Department activities and to evaluate sources of air contaminants not regulated under current provincial programs.

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Alberta Environment. 1977. *The Role and Mission of Alberta Environment and its Relationship to Program Budgeting and Management Planning.* Office of Management Training and Development. Edmonton. 11 pages.

Fisheries and Environment Canada. 1976. *Criteria for National Air Quality Objectives.* The Subcommittee on Air Quality Objectives. Ottawa. 41 pages.

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REVIEW

OF THE

CLEAN AIR ACT

1. INTRODUCTION

Air is a complex mixture of gases. It normally consists of about 78 percent nitrogen and 21 percent oxygen, plus small quantities of other gases such as carbon dioxide and hydrogen. It naturally contains a certain amount of suspended particles and water droplets. It is this particular mix that has historically been considered to be "clean, fresh air." While clean, fresh air is a resource of immense value, determining when it ceases to be clean and fresh is difficult.

The quality of fresh air is generally considered to deteriorate when the normal concentrations of gases are altered and/or new substances are added. These changes result from human activities as well as natural phenomena such as volcanos, forest fires, and dust storms. The leading source of anthropogenic air contaminants in Canada is the combustion of fossil fuels, especially by automobiles and power plants (Lang and Armour 1980). In Alberta, additional major sources include oil refining, natural gas production, and chemical and petrochemical operations.

Poor air quality can affect our quality of life in a number of ways. The most basic are the direct and indirect biological effects on plants and animals. For example, the possible impacts of air pollution on the plant components of boreal forests include elimination of sensitive species, selective removal of larger plants, and reduction in amounts of nutrients available to the ecosystem (Legge *et al.* 1980: xviii). Research into the human health effects is beginning to reveal that:

1. air pollution plays a pathogenic (disease-causing) role in chronic bronchitis, emphysema and asthma and

2. air pollution increases morbidity and/or mortality in patients with pre-existing respiratory disease (Seinfeld 1975: 26).

Poor air quality changes climatic conditions by altering temperature and wind patterns, reducing solar radiation, and causing fog formation and precipitation (Seinfeld 1975: 11). Air pollutants can affect materials through soiling or chemical deterioration, and create hazards such as poor visibility. These effects all reduce the aesthetic and recreational quality of our environment.

From an environmental point of view, the quality of the air is one fundamental measure of the ecological soundness of our growth and development as a society. In Alberta, there are a number of legislated provisions and administrative practices which attempt to protect our air quality. The intent of this report is to review these provisions, primarily the Clean Air Act, as well as the related air quality management practices in order to identify current strategies and assess their appropriateness and effectiveness for maintaining air quality. Specifically, this report addresses the management of outdoor air quality. The unique nature and importance of indoor air quality is also gaining recognition; however, a discussion of the legislation and practices that affect indoor air quality is beyond the scope of this report.

The following questions provide the basic focus of this report:

- **What is the nature of current legislative provisions for the management of air quality in Alberta?**

- **What assumptions appear to be the basis of the regulatory provisions?**

- **What administrative processes enable implementation of these provisions?**

- What roles do industry and the public currently play in preventing or minimizing air pollution?
- What is the significance of the federal Clean Air Act and other federal initiatives with respect to managing air quality in Alberta?
- What policy areas, if any, are or should be the focus of debate?

Chapter 2 discusses the jurisdictional issues surrounding management of air quality in Alberta and reviews federal and provincial legislation and policies relating to air quality. Chapter 3 identifies the processes by which specific standards are set and discusses the nature of current ambient air quality and source emission requirements. Chapter 4 outlines current provincial administrative processes and practices. Chapter 5 briefly discusses ambient air quality trends in Alberta during the last decade. And Chapter 6 provides an overview assessment of air quality management in Alberta, focusing on the special concerns evident in the preceding chapters.

To minimize lengthy references in the text, all relevant legislation and policies are summarized in Appendix A. Appendix B provides a detailed description of available ambient air quality data, 1973-1981.

2. THE LEGISLATION

Although the federal and provincial Clean Air Acts are the principal pieces of air quality legislation, current practices for managing air quality in Alberta are governed by well over two dozen legislative and policy documents.[1]

This chapter examines the allocation of responsibility for management of air quality and the scope of the legislation, looking particularly at common patterns, the variety of options and procedures offered, and the underlying strategies.

JURISDICTION FOR MANAGING AIR QUALITY

It is widely recognized that the distribution of responsibility for environmental matters in Canada is confusing and complicated (Gibson 1973, Ince 1976, Canada 1981, Manzig and Mulvaney 1982, Sandhu 1982). As the emergence of environmental control issues was not foreseen in 1867 when the British North America Act was enacted, no clear provision was made for the allocation of legislative jurisdiction over the environment to either the federal or provincial level of government. Wide powers are given to both levels of government and in practice federal, provincial, and municipal laws all influence air quality in Alberta.

Federal legislation dealing with pollution matters is based upon several constitutional powers. The federal authority to impose criminal sanctions can be applied to pollution offenses. As well, the general responsibility for peace, order, and good government gives the federal government the residual legislative powers not specifically assigned to any level of government (Gibson 1973: 83). Federal responsibilities to regulate imports allow for government requirements such as emission-control devices on imported automobiles. The federal government can also enter into international agreements related to air quality issues.

The federal government's role focuses on controlling air pollution from federally controlled works, protecting the public from exposure to hazardous pollutants by developing contaminant and industry-specific guidelines, and providing leadership in interprovincial and international environmental issues. The federal government encourages environmental research and the development of abatement technology. As well, the federal taxing power may be used to encourage industry to install effective pollution control equipment (Manzig and Mulvaney 1982).

Most aspects of environmental management, however, fit within areas of *provincial* jurisdiction. The provinces are responsible for municipal institutions, local works, property and civil rights, certain natural resources, and all matters of a local or private nature. These provisions are generally interpreted very broadly and are the basis of a great deal of environmental legislation (Ince 1976: 23). For example, the government of Alberta assumes responsibility for regulating resource exploration and development as well as regulating emissions into the air resulting from those activities. Some provincial responsibilities, such as land use planning and municipal administration, have been delegated to regional and municipal governments. For example, some municipal councils enact bylaws limiting emissions of dense smoke within the municipal boundaries, and all municipalities with a population over 1,000 must prepare municipal land use bylaws, which may influence the location of "noxious" or polluting activities.

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[1] *See Appendix A for a detailed content outline of all relevant legislation and policies.*

The first air quality legislation and policies in Alberta were developed in response to specific problems associated with oil and gas activities. In the early 1950s the Petroleum and Natural Gas Conservation Board, now the Energy Resources Conservation Board (ERCB), required that oil and gas operations meet "environmental controls related to hydrogen sulphide emissions... to forestall complaints regarding noxious odors" (ERCB 1972: 1-3). More comprehensive air quality regulations were first issued in 1961 by the Department of Health (later the Department of Environment).

SCOPE OF ENABLING LEGISLATION

The provincial and federal Clean Air Acts are the primary enabling documents on which most air quality regulations and policies are based. Alberta's Clean Air Act was assented to on April 16, 1971, preceding the federal Clean Air Act by two months. Both Acts begin by defining such basic terms as "air contaminant" and "air pollution." Air contaminant, for the purposes of both Acts, refers to any solid, liquid, or gas (the federal Act also includes odor) or combination of any of these emitted into the ambient air. The provincial Act specifies that these emissions must result directly or indirectly from human activities.

Air pollution has distinctly different definitions in the two Acts. The provincial Act (s. 1(b)) states that air pollution means:

> i. the presence in the atmosphere of any contaminant in excess of the permissible concentration prescribed in the regulations for that air contaminant, or
>
> ii. the presence of any air contaminant having an offensive odor, regardless of its concentration.

This definition is quite precise in its meaning: air pollution must exceed the regulations or be offensively smelly. An odorless contaminant for which there are no regulations prescribed cannot constitute air pollution. It should be noted, however, that this definition does not include the air in a workplace since workers' safety is governed by other legislation. The federal Clean Air Act (s. 2(1)(b)) defines air pollution as a condition of the ambient air resulting from the presence of air contaminants that endanger the health, safety, or welfare of persons, which interferes with the normal enjoyment of life or property, or which damages plant life or property. While this much broader federal approach potentially recognizes any air contaminant with detrimental environmental impact as air pollution, its imprecision may make "proving" air pollution difficult. A basic assumption of both definitions is that certain amounts of air contamination do not necessarily constitute air pollution.

The purpose of both Acts is to enable the Environment Ministers to make regulations and policies and to carry out certain activities. Specifically, the *federal* Clean Air Act allows the federal Minister to:

- formulate comprehensive plans for the control and abatement of air pollution from all federal works;

- formulate ambient air quality objectives with respect to specific air contaminants reflecting tolerable, acceptable, and desirable concentration ranges;

- develop agreements with individual provinces setting standards for air pollution;
- develop national emission standards and guidelines establishing maximum quantities and concentrations of air contaminants which pose a danger to the health of persons or which would violate a term of any international obligation.

It further specifies that the Minister may authorize extensive air pollution monitoring throughout Canada, data collection, research, and the publication of information about all aspects of the quality of the ambient air. The federal Minister is also enabled to consult with representatives of industry and labor, provincial and municipal authorities, and other persons interested in air pollution.

The *provincial* Clean Air Act enables the provincial Environment Minister to make a broad range of regulations relating to ambient air quality standards, emissions standards, and monitoring methods. It also outlines a system of permitting and licensing procedures for facilities that will contribute to air pollution. Associated provisions enable the issuance of "certificates of variance" to vary the terms of a permit, licence, or requirements of the regulations; "directives" requiring records or other information relating to the emission of air contaminants to be provided to the government; "emission control orders" to control or stop specific emissions; and "stop orders" which may require cessation of a specified contravention of the Act, regulations, or conditions of a licence. Provincial documents outline the requirements relating to air quality and the design, construction, maintenance, and operation of possible sources of air pollution.

Pursuant to these enabling provisions, both governments have adopted numerous regulations and policies relating to ambient air quality and source emissions.[2]

The federal government has passed regulations prescribing tolerable, acceptable, and desirable ambient concentrations for sulphur dioxide, suspended particulate matter, carbon monoxide, oxidants (ozone), and nitrogen dioxide. With respect to source emissions, the federal government has enacted a number of regulations stipulating maximum permissible emissions of specific contaminants from certain industries. It has also published guidelines for several other types of industrial emissions.

The provincial government has incorporated many of these federal policies into legislation. The provincial Clean Air (Maximum Levels) Regulation specifies maximum permissible concentrations of specific contaminants in the ambient air. The provincial levels are equivalent to the federal "desirable" concentrations for some air contaminants and equivalent to the federal "acceptable" concentrations for others. The regulation also stipulates maximum permissible concentrations for hydrogen sulphide and dustfall, contaminants for which no federal objectives have yet been developed. With respect to source emissions, the province has incorporated some of the federal levels into the Maximum Levels Regulation, and some into industry-specific emissions guidelines.

Both the federal and provincial Clean Air Acts specify what constitute offenses under the Acts and specify maximum penalties.

The federal Motor Vehicle Safety Act also relates to air quality. This Act enables the federal government to establish emission standards for automobiles. Other provincial legislation relevant to air quality management in Alberta includes the Environment Council Act, which authorizes a broad investigatory role for the Environment Council of Alberta in all matters related to the environment. The Council is responsible for holding public hearings on broad environmental issues as well as on specific stop order appeals. The Department of the Environment Act, in addition to giving overall responsibility for environmental matters to the Minister, establishes the Natural Resources Coordinating Council and the Conservation and Utilization Committee, inter-departmental committees responsible for ensuring comprehensive consideration of all environmental issues throughout various processes in the provincial government. This Act authorizes liaison with the federal and other provincial governments and enables various research-related activities. The Land Surface Conservation and Reclamation Act enables the requirement of Environmental Impact Assessments (EIAs) and provides for the establishment of several interdepartmental review committees which occasionally assess specific air quality management issues. Finally, the Oil and Gas Conservation Act gives authority to the Energy Resources Conservation Board (ERCB) to develop specific regulations to prevent air pollution resulting from oil and gas operations.

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[2] *Chapter 3 provides a detailed description of the federal and provincial maximum permissible levels and discusses how the levels are set. This section in this chapter is intended to provide a general perspective on the breadth of the legislative provisions.*

PATTERNS IN LEGISLATION AND GUIDELINES

Exemptions and Permitted Variance

The numerous legislative and policy documents described in the previous section, while stipulating many ambient air quality and emission requirements, also make provisions to exempt certain industries and activities from meeting specific requirements.

The provincial Clean Air General Regulation exempts a number of operations from the requirement in the Act to obtain a "licence to operate." Included are municipal sewage treatment plants, except those where digester gases are flared; meat packing plants that do not have rendering facilities and have a slaughtering capacity of not more than 25 cattle or 125 hogs per day or a combination of slaughtered livestock not exceeding 11.5 tonnes liveweight per day; thermal electric power generating plants burning natural gas, gasoline, or diesel fuel and having a connected load with a peak demand of one megawatt or less; and portable incinerators with a burning capacity of less than 200 pounds per hour which dispose of kitchen and camp wastes from drilling and exploration sites and which are at one location for less than one year. These are exempt from the licencing requirement but not from the other requirements of the Clean Air Act.

A similar type of exemption is found in the Oil and Gas Conservation Regulations, which provide the ERCB with discretion to exempt certain oil and gas wells and batteries from provisions of the regulations that relate to controlling odorous gases and protecting nearby residences from releases of H_2S. These exemptions are granted if the Board decides that the nature of the production, remoteness of the area, or other circumstances warrant it.

Examples of exemptions allowing specific activities to disregard certain emission requirements are found in the Maximum Levels Regulation. Sections 10 and 12 list various activities which may be exempted from the visible and particulate emission requirements. These include operations and activities which are not plants or structures but which will be sources of emissions into the ambient air, such as fires for community recreational events or ground thawing. Any operations or activities specifically authorized by the Director of Standards and Approvals can be exempted from these requirements. It is unclear whether these exemptions are necessary for technical reasons, economic efficiency, administrative convenience, or because the emissions from these activities are truly insignificant.

The regulations sometimes include special provisions for certain operating conditions. For example, the visible emissions requirements are relaxed during plant start up and shut down. Emission limits for fossil fuel fired thermal power generating plants in Alberta apply at all times except during periods of start up, shut down, malfunction, or under emergency conditions (Alberta Environment 1984). "Malfunction" is defined as partial or complete breakdown of equipment due to factors beyond the control of the operator. The definition of an emergency condition includes periods when the electrical generation cannot be reduced because of various system requirements and those situations when the only unit available to maintain the company's emergency reserves has a malfunctioning air pollution control system.

There are several provisions exempting older plants (those pre-dating the introduction of new standards and emission control requirements) from complying with new requirements, or at least allowing them a considerable time period (for example, five years) to acquire the necessary modifications. For example, the guideline limiting contaminant emissions from fertilizer plants and related industries delineates separate emission limits for new and existing plants. Similarly, the emission guidelines for thermal power plants apply to generating units approved after May 1, 1981 and not before.

There is also a significant provision in Alberta which authorizes non-compliance with permit or licence requirements. Sections 10 and 11 of the Clean Air Act enable the Minister to issue a "certificate of variance" if the problems result from uncontrollable factors, if the variance is not likely to result in air pollution detrimental to life or health or adversely affect property, and if refusal to permit variance would result in serious hardship to the applicants without offsetting benefits to others.[3]

Indeed, various provisions anticipate and accept certain levels of regular non-compliance. For example, Section 12.2 of the Maximum Levels Regulation permits the particulate emission standards to be exceeded in the event of a malfunction or breakdown in the air pollution control equipment for one or two hours per month depending on the process involved. In a similar vein, Information Letter 80-24 jointly issued by Alberta Environment and the ERCB clearly states that some variance from the specified sulphur recovery guidelines for gas processing operations may be appropriate where, for example, due to certain constraints, reductions in recovery efficiency requirements appear to be environmentally acceptable. In this case, the ERCB is apparently provided with considerable latitude to define these constraints and the limits of environmental acceptability.

Monitoring and Reporting Requirements

A consistent requirement of provincial legislation and policy is that industry monitor and report on its own operations and emissions. Monitoring requirements are included in government-issued operating licences.

Alberta Environment has issued six industry-specific Air Monitoring Directives that specify acceptable monitoring methods and standardization of reports. The directives also specify what is expected when notifying of non-compliance and submitting reports of uncontrolled or accidental releases. Presumably the directives not only facilitate assessment of data from a regulatory point of view, but also provide industry with a clear account of expected monitoring and reporting procedures.

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[3] *The discussion in Chapter 4 related to the administration of the Clean Air Act will take a closer look at this provision and will document the frequency of such certificates of variance being issued and the nature of the variance being allowed.*

In addition to the Air Monitoring Directives, a number of other provincial and federal provisions deal with monitoring. For example, Section 12.8 of the Maximum Levels Regulation requires operators of vinyl chloride or polyvinyl chloride plants to monitor the atmosphere in the vicinity of their plants for the presence of vinyl chloride. Another example is found in the emission guidelines for fossil fuel-fired thermal power generating plants. These guidelines require operators to provide a continuous monitoring system for measuring the opacity of the effluent stream as well as sulphur dioxide, carbon dioxide, and nitrogen oxide concentrations.

Some testing and monitoring requirements are governed by performance codes. For example, the Maximum Levels Regulation requires all atmospheric monitoring for lead-bearing particulates from a secondary lead smelter to conform with the federal Standard Reference Method for the Determination of Lead in Airbourne Particulates (Atomic Absorption Spectrophotometry) (Environment Canada 1976). The Alberta Stack Sampling Code (SSC-1/76) establishes an explicit methodology for manual stack emission testing. The industry-specific Air Monitoring Directives require that all manual stack emission surveys conform with this Code and required reports are to be prepared as outlined in the Source Emission Survey Format (AMD-79-3). For continuous emission monitors, some performance specifications do exist, such as for thermal power plants and oil and gas plants (Alberta Environment 1984, 1982a). However, a general performance code for continuous emission monitors is only now being developed (W.S. Macdonald 1983: pers. comm.).

Although the monitoring and reporting requirements essentially require industry to do the job, there are provisions for witnessing. For example, operators of sour gas plants are required to provide the ERCB with advance notification of their scheduled stack sampling dates to enable the Board to be present to ensure that the sampling is done according to requirements (Alberta Environment 1982a: 17). Section 12.3(4b) of the Maximum Levels Regulation stipulates that stack surveys for secondary lead smelters shall only be carried out in the presence of an authorized employee of Alberta Environment.

Clearly the legislation and related policy documents place the responsibility on the industries to monitor themselves and provide appropriate data and reports. Somewhat less clear is whether there are adequate legislated and policy provisions to guarantee that the quality and comprehensiveness of the monitoring is uncompromised by this approach. Requiring industry to submit potentially self-incriminating information raises practical questions concerning a company's forthrightness during difficult situations and the use of such information in prosecutions.

Violations and Penalties

Monitoring and reporting provisions in the provincial and federal policies theoretically enable both industry and government to know when pollution standards or requirements of operating licences are being contravened. What, then, are the consequences of contraventions? The legislation relating to air quality management specifically identifies what constitutes an offense and stipulates maximum penalties.

Two key offenses are found in the provincial Clean Air Act. Sections 3 and 4, respectively, identify construction of specified facilities without a permit or in contravention of a permit condition as an offense, and operation of these facilities without a licence or in contravention of a licence condition as another offense. Thus, contravention of the emission standards incorporated into a "licence to operate" is an offense. The resulting penalty may be a fine of up to $25,000 and, in default of payment, a term of imprisonment not exceeding three months (s. 16). Prior to 1982, the maximum fine was $5,000.

The Clean Air Act contains three important enforcement tools: directives, emission control orders, and stop orders. Section 15(3) enables the Director of Pollution Control to direct a plant operator to provide specified information. This takes the form of an air quality directive. Failure to comply is an offense liable to a fine of not more than $5,000 for each day the offense continues.

Section 13 enables the Director of Pollution Control to issue emission control orders if it is determined that there exists an air contaminant in concentrations exceeding maximum permissible concentrations or maximum permissible visible emissions, with an offensive odor, or likely to be detrimental to life or health or to adversely affect property. An emission control order may also be issued if a licence has been or is about to be contravened. Such orders may limit or control the rate of emission of a contaminant, stop the emission of a contaminant permanently or for a specified period, require compliance with directions, require equipment installation or repair, or require measurement of rate of emission and/or ambient concentration. Non-compliance with an emission control order is an offense subject to the same penalties as for contravening a permit or licence (not exceeding $25,000).

Section 14 of the Clean Air Act enables the Minister to issue a stop order if the Act, an order under the Act, regulations, or conditions of a licence are contravened; if directions from the Director of Pollution Control are not being complied with; or if any plant, structure, or thing is a source of air pollution of immediate danger to human life or property. A stop order may require the cessation of a specific activity or may actually stop plant operations permanently, or for a specified period. The contravention does not have to constitute a specified offense. Failure to comply with a stop order is an offense liable to a maximum fine of not more than $50,000 for each day that the offense continues, or to imprisonment of not more than 12 months, or both fine and imprisonment. Prior to 1982 the maximum fine was $10,000.

Clearly a ministerial decision to issue a stop order is a much more severe restraining action than a directive or an emission control order issued by the Director of Pollution Control. Stop orders are to be utilized when there is an immediate danger to human life or health or when there are contraventions of the Act, regulations, licence conditions, or a directive. Directives and emission control orders are to be used to obtain information and conformity with licences and regulations. Thus, while emission control orders would control certain emissions or require installation or repair of equipment, stop orders actually require the contravention or all operations to cease either permanently or for a specific period. If an operator does not comply, the department may apply for a Court Order to shut the plant down themselves. Because of its severity, a stop order may be appealed. The Environment Council of Alberta is then required to hold an inquiry into the issues surrounding the stop order.

Similar enforcement tools have been provided to the Energy Resources Conservation Board. The authority to issue directives and emission control orders to operators of natural gas processing plants and thermal power plants has been delegated to the ERCB through regulations under the Clean Air Act (AR 88/74 and AR 89/74). Furthermore, Part 9 of the Oil and Gas Conservation Act authorizes the ERCB to suspend any operation at an oil or gas well or battery should the operator fail to comply with the Act, associated regulations, or an order from the ERCB. Following an inquiry, the ERCB can shut the well or battery down. The Board has similar authority over gas processing plants pursuant to the Oil and Gas Conservation Regulations (AR 151/71).

Another type of offense identified in the legislation concerns supplying information to the government, and facilitating government investigation. Section 15.3 of the provincial Clean Air Act makes it an offense to supply false information in reports required by the Act or regulations. A maximum fine of $25,000 is available. Section 15 of the Act enables an authorized person to enter premises to investigate anything that is, or contains, a source of air pollution. Failure to permit such an investigation may result in the authorized person applying to the Court of Queen's Bench for an order enforceable by a sheriff. Failure to comply with such an order, or to provide specified information, is an offense liable to a maximum fine of $5,000 per day. Prior to 1982, the maximum fine was $1,000.

This latter provision (Section 15) has also been delegated to the ERCB. In addition, Section 88 of the Oil and Gas Conservation Act enables Board members or persons authorized by the Board to have access to all wells, equipment, plants, and records. They are entitled to inspect all premises, books, equipment, and to take samples or carry out any tests. Obstruction of such persons is an offense which may result in fines of between $300 and $1,000 in the first instance and, if continued, of between $100 and $500 per day for each subsequent day. It appears that the Board has more direct power in obtaining information than the Department of the Environment.

As noted in the previous subsection, the Clean Air General Regulation requires that any uncontrolled, unauthorized, or accidental release of air contaminants be reported within specified time periods. Failure to report such incidents is an offense which may result in a fine not to exceed $1,000 for each day that the contravention continues.

The Clean Air General Regulation also contains a general prohibition against emitting air contaminants. Section 5 states that "the release of toxic air contaminants to the atmosphere is prohibited unless written approval of the Director of Standards and Approvals has first been obtained". Unfortunately, there is no definition of "toxic" in the regulation. Contravention of this section is an offense which may result in a fine of up to $1,000 for each day that the contravention continues. Since all licenced operations have the written approval of the Director of Standards and Approvals, this section appears to deal with those activities that are not specifically required to obtain a licence to operate. If prosecution were to proceed under this section, the need to establish "toxicity" may greatly complicate the case.

The most serious of the offenses defined in the federal Clean Air Act appears to be the contravention of national emission standards established by the federal government where specific air contaminants constitute a significant threat to human health or where they would result in violation of a term of an international obligation. The maximum penalty for this offense is $200,000, the largest of all maximum penalties. As noted in earlier sections of this chapter, there are national emission standards for secondary lead smelters, asbestos mining and milling, and chlor-alkali mercury and vinyl chloride plants.

DISCUSSION

The basic underlying assumption of the provincial legislation and associated policies is that emitting certain low levels of contaminants into the ambient air does not constitute air pollution. Air pollution is provincially defined in terms of exceeding permissible concentrations prescribed in the regulations. The regulations presumably set non-polluting thresholds. The responsibility of the provincial government (with assistance from the federal government) is to identify safe concentrations of various contaminants in the ambient air and then to prevent emissions from causing those thresholds to be exceeded.

Both the federal and provincial governments have regulations stipulating these ambient air quality thresholds for the "traditional" air quality parameters — sulphur dioxide, nitrogen dioxide, carbon monoxide, oxidants (ozone), and suspended particulates. Alberta also specifies thresholds for hydrogen sulphide and dustfall. Both levels of government have also adopted regulations and established guidelines prescribing emission standards. Most of these are directed toward specific industrial sectors, although Alberta does have general standards for visible and particulate emissions. The strategy is to ensure acceptable ambient air quality by controlling certain emissions.

With this general philosophical framework in mind, a few observations can be made about the patterns evident in the legislation and policy documents.

The legislation and policies provide a wide variety of types of exemptions. There are provisions for exempting certain operations from having to obtain licences; for waiving emission limits during certain times such as start-up, shut-down, and malfunction; for waiving certain regulations if an operation is remote or other circumstances warrant it; for formally authorizing non-compliance by use of a certificate of variance; and for exempting plants that existed prior to the introduction of new maximum permissible emission requirements from having to achieve those levels, at least for a certain period of time. Although the exemptions undoubtedly are a practical way of legitimizing insignificant or unavoidable emissions, critics argue that they provide too many convenient opportunities for environmental considerations to be set aside (Duncan 1980: 95). The policy documents imply that exceeding the standards is to be expected as a result of periodic circumstances, such as equipment breakdown and unusual weather conditions. Certainly the Minister, the Director of Standards and Approvals, and the ERCB may use considerable discretion in deciding which exemptions will be environmentally acceptable. But how do these officials decide what is "acceptable"? There is little guidance provided for how the meaning of "acceptable" is to be determined. Consideration should be given to seeking such guidance from the public.

Considerable discretion is also characteristic of the monitoring and enforcement provisions. The legislation gives power to the Director of Pollution Control to do something if it is evident that violations are occurring, but doesn't specify what action should be taken (Kupchanko 1982: 49). While the legislation provides for a variety of enforcement actions ranging from requesting more information to issuing emission control orders and stop orders, there is a lack of any provision to ensure that those who are responsible for enforcement are held accountable.

A significant feature of the monitoring and reporting provisions is that industry is required to monitor and report on its own operations and emissions. Considerable direction regarding what and how they are to monitor and report is provided in the legislation and directives, and incorporated into the permits and licences. But there are gaps. Performance codes for most continuous source emission monitoring systems are lacking. Self-monitoring in a program with strong quality assurance checks can provide data which can be used in various ways, to monitor compliance as well as to evaluate the appropriateness of current requirements. However, self-monitoring is a cause for concern in cases where the spirit of co-operation may be somewhat lacking.

This review of the legislation identifies various legal ambiguities which may pose problems for the administration. First, although the provincial Clean Air Act clearly identifies contravention of a permit or licence condition as an offense, there are many exemption provisions which legitimize such incidents for a number of very general reasons, such as malfunction and repair. Second, although the Clean Air General Regulation prohibits the unauthorized release of toxic air contaminants, the absence of a definition of "toxic" may complicate litigation under this provision.

The five-fold increase in 1982 in the penalty provisions contained in the provincial Act suggests that contraventions are now viewed with greater seriousness. The province's maximum penalty now is $50,000 a day or imprisonment for up to a year or both for contravening a stop order. The 1983 amendment making it an offense to report false information may alleviate some of the concern about self-monitoring. However, these changes must be accompanied by an indication that the government is willing to use these provisions.

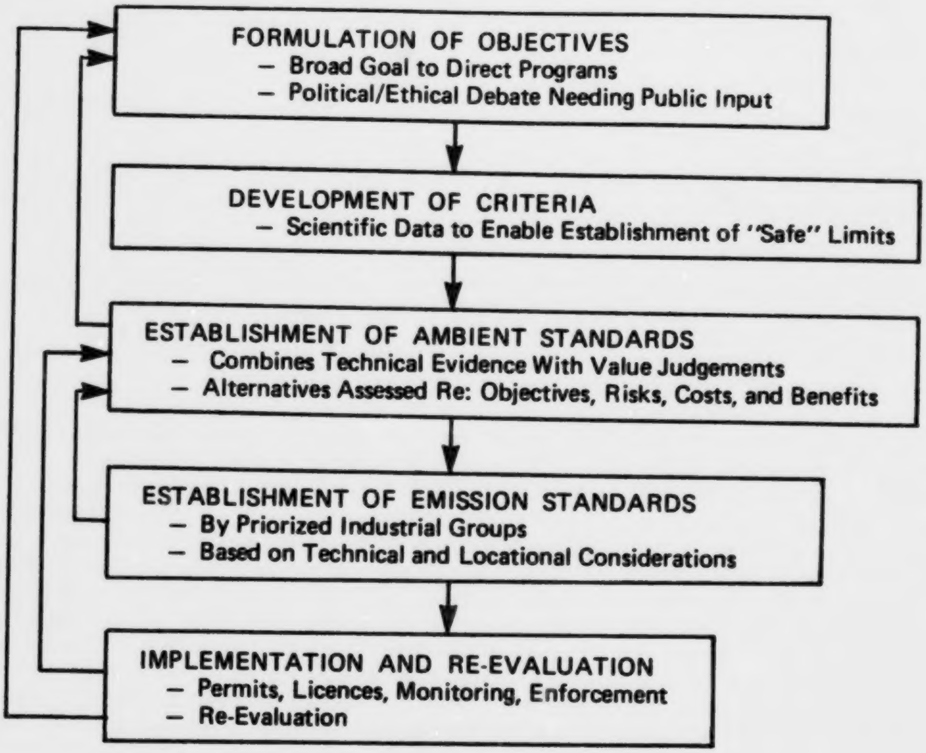
3. AIR QUALITY STANDARDS

As pointed out in the preceding chapter, in Alberta air pollution is defined in terms of exceeding permissible concentrations of air contaminants. Thus, in order to administer the Clean Air Act, there is need for air quality standards specifying these permissible concentrations to provide the basis for determining compliance and non-compliance with the Act. This chapter discusses how standards are set in Alberta in the context of a model standard-setting process developed by Franson *et al.* (1982). Then the actual ambient and emission standards are reviewed in detail.

THE STANDARD-SETTING PROCESS

The model developed by Franson *et al.* (1982) to describe a general standard-setting process consists of five elements (see Figure 1).

Figure 1 A Model Standard-Setting Process


FORMULATION OF OBJECTIVES
– Broad Goal to Direct Programs
– Political/Ethical Debate Needing Public Input
DEVELOPMENT OF CRITERIA
– Scientific Data to Enable Establishment of "Safe" Limits
ESTABLISHMENT OF AMBIENT STANDARDS
– Combines Technical Evidence With Value Judgements
– Alternatives Assessed Re: Objectives, Risks, Costs, and Benefits
ESTABLISHMENT OF EMISSION STANDARDS
– By Priorized Industrial Groups
– Based on Technical and Locational Considerations
IMPLEMENTATION AND RE-EVALUATION
– Permits, Licences, Monitoring, Enforcement
– Re-Evaluation

Source: Franson et al. 1982

Step 1: Formulation of Objectives

It is important for air quality management programs to identify goals or objectives that will provide the basis for the strategies which follow. The most common type of objective relates to the protection of human health and there is increasing recognition of ecological principles which focus on maintaining the integrity of a resource rather than solely on the economic principle of beneficial use (Franson *et al.* 1982: 25).

Formulation of such objectives essentially involves political/ethical decisions as opposed to technical and legal inputs. For this reason, Franson *et al.* argue for the systematic provision for public input in setting these objectives (Franson *et al.* 1982: 27).

Alberta Environment's role document appears to provide the only broad statement of goals applicable to this discussion. The stated role of the department is "to promote a balance between resource management, environmental protection and the quality of life" (Alberta Environment 1977a: 2). With regard to the department's pollution prevention and control program, the objective is "to prevent or control pollution in order to protect the environment and the quality of life" (Alberta Environment 1977a: 5). The air quality program appears to be primarily guided by a number of specific operational policies, such as controlling pollution at its source, placing the financial responsibility for pollution abatement and cleanup on the polluter, and requiring polluters to monitor their emissions (Alberta Environment 1977a). However, other than the very general goal of protecting the environment and quality of life, which may have as many interpretations as there are individuals who care to define what that means to them, there is a lack of explicit objectives upon which to base such strategies.

Step 2: Development of Criteria

Criteria are the scientific and technical data on which standards are based. For example, if the objective is to protect human health, it is necessary to be able to establish what levels of air contamination threaten it. This is a very difficult task because increasing numbers of new chemicals are being synthesized yearly and emitted as contaminants. The exposure level at which a substance becomes harmful is rarely clear-cut because sensitivity to a substance varies over a broad range. Furthermore, the synergistic and antagonistic effects among contaminants are poorly understood. Thus it is critically important to recognize the potential inadequacies of the technical criteria which are used to determine the ambient air quality standards and to continually ask new questions which will increase our understanding of the full impact of air contaminants.

Most of Alberta's ambient air quality standards are based on federal standards, for which the criteria are determined by the Federal-Provincial Committee on Air Pollution's Subcommittee on National Air Quality Objectives. This subcommittee not only develops new objectives but reviews existing objectives on an ongoing basis (S.L. Dobko 1983: pers. comm.). Thus, while the subcommittee's documentation of criteria used for establishing the national air quality objectives (Fisheries and Environment Canada 1976) indicates that current ambient standards are based on technical studies that are almost all at least 10 years old, more current research is evaluated during ongoing reviews. The federal Atmospheric Environment Service conducts some research related to the nature, transportation, dispersion, and effects of air pollution (Environment Canada 1975). The Alberta Environmental Research Trust, Alberta Environmental Centre, and Research Management Division of Alberta Environment also finance or conduct some air quality related research. However, further research is needed to strengthen the basis for standard-setting in Alberta.

Step 3: Establishment of Ambient Standards

Ambient standards are a prescription of the quality of air "that is deemed necessary to protect the desired objectives, in the light of scientific knowledge supplied by the criteria and of socio-economic factors affecting the control of pollution" (Franson *et al.* 1982: 31). Setting ambient standards involves not only technical decisions but value judgements as well. On the basis of in-house technical evaluation of the criteria, alternative standards may be identified and assessed in terms of how well the objectives are met, the benefits and costs of each, and the acceptability of associated risks.

As indicated in the preceding discussion of criteria, most of Alberta's ambient standards are based on the federal ambient standards which were developed by the Federal-Provincial Committee on Air Pollution. This committee is chaired by the Federal Air Pollution Control Director General and includes senior officials from the provinces, including Alberta (Franson *et al.* 1982: 92). Other ambient standards were carried over from the Provincial Board of Health which had certain responsibilities in this area prior to the formation of the Department of the Environment.

Because value judgements are being made at this stage, Franson *et al.* (1982: 34) suggest it is desirable to encourage the public to comment on the proposed standard, to identify whether other criteria may be necessary, to state preferences concerning unquantifiable matters, and to give views on the acceptability of the risks. Undoubtedly this would lead to increased confidence in the appropriateness and meaning of ambient standards. Alberta Environment recognizes that "ambient air quality standards determine what are considered to be the concentrations of various air pollutants that are acceptable to the public in Alberta" (Alberta Environment 1983a: 2). However, there does not appear to be any form of consultation to determine the concentrations that are publicly acceptable.

Step 4: Establishment of Emission Standards

Emission standards are intended to define the limits on contaminant discharges which are necessary to maintain the ambient air quality standards. Emission standards are also required because contraventions of ambient standards by themselves would be extremely difficult to enforce. For example, it is difficult to identify who is to blame if ambient air quality standards in downtown Edmonton or Calgary are exceeded. As a consequence, implementation of ambient standards is a matter of identification and control of individual emission sources.

The main factor considered in developing emission standards is the toxicity of the contaminant. Mathematical models which involve analyses of the cost of control measures subject to various constraints (such as achieving desired ambient air quality, or perhaps ensuring uniformity of treatment requirements or prohibiting certain methods of treatment) are also used in their formulation. The upper limit of emissions is constrained by the ambient regulations. The degree to which the emissions are under the limit is a function of technology, since the application of emission technology may result in considerably lower emissions. An important technical consideration at this stage is that the efforts to control pollution of the three basic elements of our biosphere — air, water, and land — be co-ordinated. Ignoring the ecological relationships may result in policy decisions based on incorrect cost information, as evidenced by the acid rain problems in eastern Canada. In this case, the strategy of using tall stacks to disperse the emissions to protect local air quality has caused water and land quality to deteriorate in distant deposition areas.

Emission standards for most air contaminants are based upon the best *practicable* technology (BPT). Such technology is in general commercial use, is economically feasible, and adequately controls emission levels (Franson *et al.* 1982). For especially hazardous contaminants, such as vinyl chloride monomers and lead, best *available* technology (BAT) is employed. BAT is abatement technology that has been successful in pilot projects and can be expected to work at the required scale. Economics are not a consideration in determining BAT (Franson *et al.* 1982: 8).

A basic premise of Alberta Environment's air-quality program is that "environmental protection can best be achieved if government and industry work together and not against each other" (Kupchanko 1982: 35). This philosophy can be illustrated in the setting of industrial emission standards. The current practice is "to establish a government-industry task force which advises the decision-makers on the emission rates associated with BPT (best practicable technology) and suggests realistic implementation schedules" (Lack 1980: 9). This allows industry experts to provide information about the state of technology, associated costs, and so on, and to influence the government regulations to a certain degree. This task force approach has been followed for developing emission standards for sour gas plants, the fertilizer industry, anhydrous ammonia storage, foundries, and the asphalt industry (Lack 1980: 9). By including input from industry, technically attainable emission standards should be achieved and excellent compliance should be expected.

A number of commentators (Franson *et al.* 1982, Economic Council of Canada 1981, Thompson 1980, Organization for Economic Co-operation and Development 1980) point out that the determination of "best practicable" or "best available" technology leaves a great deal to administrative discretion and is highly dependent on bargaining. Such bargaining can result in inefficiencies and inequities. For example, there is little incentive for companies to invest in improvements in the currently accepted technology, which may be less than exemplary. Some analysts are suggesting that "a shift towards increased use of incentive systems in which polluters would find it in their interest to reduce emissions" is desirable (OECD 1980: 57). They argue that

> *...emission charges and user fees would improve the ability of the public to take account of environmental damages caused by production, would result in further pollution abatement and would provide the necessary funds to finance environmental public expenditures (OECD 1980:56-57).*

If Franson *et al.* (1982: 47) are right in their observation that from a North American perspective "the pendulum is about to swing back (from technology-based standards) toward a more quality-based approach", then more efficient and equitable incentive programs could be forthcoming.

Step 5: Implementation and Re-evaluation

The final stage in the standard-setting process involves monitoring, enforcing, and re-evaluating the standards. A critical question to ask at this stage is whether the ambient standards are being achieved, and if so, whether this leads to achieving the basic goals and objectives. The answers depend upon thorough monitoring of both emissions and ambient conditions. Evaluation of the adequacy of current practices must also consider new technical, social, and economic developments relevant to the entire process.

ALBERTA'S AMBIENT AIR QUALITY STANDARDS

Maximum permissible concentrations of certain contaminants in the ambient air are established in Part 1 of the Clean Air (Maximum Levels) Regulation. The maximum permissible concentrations in the Maximum Levels Regulation are presented in Table 1. It is not an offense to exceed these concentrations.

TABLE 1. Maximum Permissible Concentration of Air Contaminants in the Ambient Air

Contaminant	Standard		
	one-year	24-hour	one-hour
sulphur dioxide[1] ($\mu g/m^3$)	30	150	450
hydrogen sulphide[1] ($\mu g/m^3$)	-	4	14
nitrogen dioxide[1] ($\mu g/m^3$)	60	200	400
carbon monoxide[1] (mg/m^3)	-	6[2]	15
oxidants as equiv. ozone[1] ($\mu g/m^3$)	-	50	160
suspended particulates ($\mu g/m^3$)	60	100	-
total dustfall[3] ($mg/100\ cm^2/30\ d$)	residential and recreational areas 53 commercial and industrial areas 158		

[1] at standard conditions
[2] eight-hour average
[3] making due allowance for normal background levels

Source: *Clean Air (Maximum Levels) Regulation*

Alberta's standards for sulphur dioxide (one-year, 24-hour, and one-hour averages), suspended particulates (one-year average), carbon monoxide (eight-hour and one-hour averages) and nitrogen dioxide (one-year average) are equal to the federal maximum *desirable* concentrations. According to the Federal-Provincial Committee on Air Pollution (FPCAP), the achievement of these levels will result in "no effect on any receptor" (Fisheries and Environment Canada 1976: 2). The 24-hour and one-hour standards for nitrogen dioxide and oxidants as equivalent ozone are the same as the FPCAP's maximum *acceptable levels*. These are intended to provide realistic objectives which will provide at least adequate protection to all parts of the environment (Fisheries and Environment Canada 1976: 1).

In the original provincial regulation (AR 218/75), the maximum permissible concentrations for oxidants were equivalent to the maximum desirable levels. However, they were raised to their present values in September of 1979 because the high natural background levels of ozone made it difficult to avoid exceeding the original regulation (W.S. Macdonald 1983: pers. comm.). This problem had been foreseen by the FPCAP which warned that "difficulties may be encountered in meeting the maximum desirable limits (for oxidants) at certain times of the year" (Fisheries and Environment Canada 1976: 17).

The FPCAP has also recommended levels for hydrogen sulphide and fluorides. These levels have yet to be formally adopted as national objectives; nevertheless, Alberta's maximum permissible concentrations for hydrogen sulphide are based upon the proposed maximum *acceptable* levels of the committee. Alberta will probably adopt the fluoride objectives as well, after they have been finalized as national air quality objectives (S.L. Dobko 1983: pers. comm.).

Unlike the other parameters, the maximum permissible dustfall rates specified in the Maximum Levels Regulation are not based upon national objectives. The prescribed dustfall rates were originally adopted by the Provincial Board of Health in the early 1960s. They were developed primarily because of the nuisance associated with dust as opposed to any environmental or health hazard. According to the regulation, due allowance must be made for background levels of dustfall. Since no method for determining such background levels is described and "background" levels in Alberta have not been established, the utility of this standard is questionable.

In addition to the Maximum Levels Regulation, Alberta Environment has non-legislated guidelines for several other ambient air quality parameters (Table 2). The soiling index, like the dustfall rate, originated with the Provincial Board of Health. The guidelines for total sulphation (sulphation rate) and hydrogen sulphide apply to a monitoring method using exposure cylinders and plates that are exposed in the field for approximately four weeks. The levels that were chosen for these guidelines were determined by examining historical data and relating monitored levels to incidents of leakage, flaring or breakdown (A. Schulz 1983: pers. comm.). There are two guidelines related to fluoride concentrations: a guideline for fluorides in vegetation of 35 ppm fluorine in forage, measured dry and unwashed, and a guideline for fluoride exposure cylinders of 40.0 µg fluorides/ 100 cm^2 / 30 days (AMD-79-1).

TABLE 2. Other Provincial Guidelines for Ambient Air Quality

Parameter	Provincial Guideline
Soiling Index	At least 90 percent of the readings during a month shall be less than 1.0 COH (coefficient of haze unit)
Total Sulphation	0.50 SO_3 equivalent mg/ 100 cm^2/d
Hydrogen Sulphide	0.10 SO_3 equivalent mg/ 100 cm^2/d
Total Fluorides	40 µg/ 100 cm^2/30d 35 ppm fluorine in forage (dry and unwashed)

Source: *Data from various sources. Provided by Air Quality Control Branch, Pollution Control Division, Alberta Environment*

ALBERTA'S EMISSION STANDARDS

Alberta has a number of emission standards which apply broadly to most stationary sources of air contaminants, and several others which are specific to certain industrial processes (Alberta Environment 1983b). Parts 2 and 3 of the Maximum Levels Regulation stipulate emission standards for opacity of visible emissions and the quantity and size range of particulates for most stationary sources. Visible emissions shall not exceed an opacity of 40 percent averaged over six consecutive minutes except for certain exemptions. The method for measuring opacity is also explained. The particulate emission standard (Table 3) for most sources is 0.20 pounds of particulates per 1,000 pounds of emissions. Again exemptions are provided and higher levels (0.60 and 0.50 pounds) are permitted for certain activities, such as seed cleaning and wood processing plants located in "smaller" urban areas (under 50,000 population) or rural areas.

The Maximum Levels Regulation also contains emission standards pertaining to specific industries. Limits on the concentrations of particulates and the lead content of emissions from secondary lead smelters are stipulated (Table 3). Permissible concentrations of vinyl chloride in the emissions from vinyl and polyvinyl chloride plants are also given (Table 3). Although the maximum permissible levels of 10 ppm and 0.002-0.2 kg/100 kg of PVC produced are equivalent to the National Emission Standards promulgated under federal regulation (Appendix A, Sections 2.3 and 2.8), the provincial standard also includes limits to reduce fugitive emission losses which the federal standards do not.

TABLE 3. Emission Standards in the Maximum Levels Regulation

Type of Facility	**Contaminant**	**Standard**
all stationary sources with exceptions	particulates	0.2-0.6 pounds/1000 pounds of effluent (depending on the type of process)
secondary lead smelters	particulates	0.023-0.046 g/normal m^3 of effluent (depending on the type of process)
	lead	0.014-0.029 g/normal m^3 of effluent (depending on the type of process)
vinyl chloride and polyvinyl chloride plants	vinyl chloride	10 ppm and 0.002-0.2 kg/100 kg of PVC produced (depending on the type of process)

Source: *Clean Air (Maximum Levels) Regulation*

Unlike the ambient standards, the emission standards in the Maximum Levels Regulation are legally enforceable. The Clean Air (General) Regulations (s. 10) state that it is an offense to exceed the provincial emission standards. And under Section 33 of the federal Act it is an offense to contravene the federal emission standards which have been established for the secondary lead smelter, vinyl chloride, chlor-alkali mercury, and asbestos mining and milling industries.

In addition to the standards outlined in the Maximum Levels Regulation, Alberta Environment has produced a number of emission guidelines for other industries (Appendix A, Sections 1.6 and 1.7). These guidelines are not enforceable until they are incorporated into individual operating licences. Input from industry was used to develop emission guidelines for fertilizer manufacturing and related processes, such as the production of acids. The parameters considered include sulphur dioxide, sulphur trioxide, sulphuric acid mist, nitrogen oxides, fluorides, free ammonia, and particulates. These emission standards are expressed as a certain amount of contaminant per unit of product manufactured (Table 4). Maximum calculated half-hour concentrations at ground level are also stipulated.

Alberta Environment also has emission guidelines for fossil fuel fired thermal power generating plants. Limits on the emission of particulates, nitrogen oxides, and sulphur dioxide are set out (Table 4). These standards are based upon the amount of heat input during power generation (that is, nanograms of contaminant per joule of heat input). A limit is also set for the opacity of the emission stream.

Other Alberta Environment guidelines include environment control policies for the location of ammonia storage facilities and asphalt paving plants, and standards for designing and operating incinerators (Appendix A, Section 1.8). Although they do not limit emissions per se, these outline design and operating principles intended to protect air quality.

A final set of guidelines of particular importance to the implementation of emission standards is the guidelines for plume dispersion calculations. The intent of these guidelines is to prescribe methods for calculating stack designs which will ensure that emissions are sufficiently dispersed so that ambient air quality standards are not exceeded. Factors contributing to stack design calculations include existing and projected industrial plant operations, present and future land use in the vicinity, present and future population density in the vicinity, transportation patterns, aesthetics, climatic and topographic characteristics of the area, and other pollution sources, particularly the location of other industrial plumes. For example, in areas where there is a possibility of several plumes overlapping, "each emitting facility, which must be constructed to operate within the design criteria, is allocated a portion of the ambient guidelines" (Kupchanko 1982: 39).

Numerous exemptions are provided in the emission guidelines. For example, periods of start-up, shut-down, and malfunction are exempted from the emission guidelines for the fossil fuel fired thermal power generating plants. Double standards are found in both the federal and provincial industry-specific emission guidelines specifying different requirements for new plants as opposed to existing plants. In the cement industry national emission guidelines, new kiln plants are permitted up to 0.9 pounds of particulate matter per ton of clinker produced or consumed while existing plants are allowed to emit 1.6 pounds. Another approach is found in the provincial guidelines which, in limiting contaminant emissions from fertilizer plants, provide a two-stage reduction program for plants *existing* at the time the guidelines were introduced. The first stage involves process modifications not requiring large capital outlays, to be achieved by a specified date. The second stage requires further reduction of emissions to meet more stringent standards, some of which are the same as for new plants. The period of grace provided for existing plants in this case was five years (February 1976 to January 1981). The practical need for special provisions for older plants is clear. However, the problem with merely setting less stringent requirements for an indefinite period (presumably until all older plants die a natural death) is that the policy contributes to prolonging the life of older, polluting plants. Alberta Environment avoids this problem for some contaminants, such as sulphur dioxide, by requiring uniformity by a certain date. For other contaminants, such as nitrogen oxides, older plants are never required to meet the standards of new plants. It appears that this is because the control technologies for sulphur dioxide are more easily retrofitted than those for nitrogen oxides.

TABLE 4. Provincial Guidelines for Industrial Emissions

Industrial Process	**Contaminant**		**Standard**
Fertilizer and Related Industries[1]:			
sulphuric acid production	SO_2		4 lbs/ton of 100% acid produced 6 lbs/ton (24-h average) 7.2 lbs/ton (1/2-h average) 0.20 ppm*
	SO_3 and acid mist		0.15 lbs/ton (24-h average)
nitric acid production	NO_x as NO_2	- new plants (for design):	3 lbs/ton of 100% acid produced
		- new plants (for operation):	4.5 lbs/ton (24-h average) 5.5 lbs/ton (1/2-h average)
		- old plants (for design):	7 lbs/ton of 100% acid produced
		- old plants (for operation):	10 lbs/ton (24-h average) 12 lbs/ton (1/2-h average)
		- all plants:	0.20 ppm*
phosphoric acid production	soluble fluorides as HF		0.025 lbs/ton of acid produced 5.0 ppb*
urea synthesis	free ammonia	- new plants (for design):	1.5 lbs/ton urea (24-h average)
		- new plants (for operation):	2.5 lbs/ton (24-h average)
		- old plants (entire plant):	2.0 ppm NH_3
		-all plants:	2.0 ppm* NH_3
urea prilling or granulation	free ammonia	- new plants (for design):	2.0 lbs/ton urea (24-h average)
		- new plants (for operation):	3.0 lbs/ton (24-h average)
		- all plants (entire plant):	2.0 ppm* NH_3
	particulates		0.20 lbs/1000 lbs of effluent
ammonium nitrate prilling	free ammonia	- all plants (entire plant):	2.0 ppm* NH_3
	particulates		0.20 lbs/1000 lbs of effluent
ammonium phosphate production	soluble fluorides as HF	- new plants:	0.03 lbs/ton (24-h average)
		- old plants:	0.05 lbs/ton (24-h average)
		- all plants:	5.0 ppb*
	free ammonia	- all plants (entire plant):	2.0 ppm* NH_3

**maximum cumulative 1/2 hour calculated ground-level concentration considering entire plant complex*

Source: [1]*Alberta Environment 1976*
[2]*Alberta Environment 1984*
[3]*Alberta Environment 1977b*

TABLE 4. Provincial Guidelines for Industrial Emissions (Continued)

Industrial Process	Contaminant		Standard
ammonium phosphate production (continued)	particulates		0.2 lbs/1000 lbs of effluent
phosphate rock grinding	soluble fluorides as HF		5.0 ppb*
	particulates		0.20 lbs/1000 lbs of effluent
ammonium nitrate production	free ammonia	- new plants (for design):	0.5 lbs/ton (24-h average)
		- new plants (for operation)	1.0 lbs/ton (24-h average)
		- old plants (entire plant):	2.0 ppm
		- all plants:	2.0 ppm*
	particulates		0.20 lbs/1000 lbs of effluent
ammonia synthesis	free ammonia	- new plants (for design):	2.0 lbs/ton (24-h average)
		- new plants (for operation):	3.0 lbs/ton (24-h average)
		- old plants (entire plant):	2.0 ppm
		- all plants:	2.0 ppm*
Thermal Power Generation[2]:			
(guidelines for new plants only)			
	particulates		43 ng/joule of heat input/h
	visible emissions		20% opacity and one 6-minute period/h at up to 40% opacity
	NO_x as NO_2		86 - 258 ng/joule of heat input (720-h rolling average) (depending on fuel type)
	SO_2		258 - 516 ng/joule of heat input (720-h rolling average) (depending on fuel type)
Asphalt Production[3]:	particulates		0.20 lbs/1000 lbs of effluent

**maximum cumulative 1/2 hour calculated ground-level concentration considering entire plant complex*

Sources: [1] *Alberta Environment 1976*
[2] *Alberta Environment 1984*
[3] *Alberta Environment 1977b*

DISCUSSION

An important component of air quality regulation is the establishment of appropriate standards. An explicit goal for air quality management provides a sound basis and direction for standard-setting. Although Alberta Environment has issued statements concerning its general role in protecting the environment, a clear direction for air quality management is lacking.

Ambient standards are selected according to available information on the effects of various concentrations of air contaminants. Given the rapidly increasing numbers of new chemicals being synthesized and emitted, as well as the recognized lack of comprehensive understanding of the synergistic, antagonistic, and long-term sub-lethal effects of contaminants, it is important that the criteria are periodically updated and re-evaluated for adequacy. More research that is relevant to this evaluation is needed.

Industrial emissions are limited to ensure that ambient air quality is protected. Government and industry work together to determine the appropriate technology on which emission standards are based. Incentives for industry to further improve pollution control could benefit this aspect of air quality management.

Public input to the standard-setting process is needed where value judgements are made. This is most important in formulating an overall goal for air quality management and in evaluating the risks associated with ambient standards. Given sufficient public input at these stages, setting emission standards becomes a technical matter that can be carried out by government and industry.

The review of the actual ambient and emission standards reveals that Alberta ambient standards are a blend of the federal maximum desirable and acceptable standards. Alberta emission standards are equivalent to national emission standards where such exist. While human health effects are a primary factor in determining standards, the nuisance factor is also considered in Alberta. For example, Alberta has established a standard for dustfall and guidelines for soiling, contaminants which are not covered in the national objectives.

It is interesting to note that the standards are specified in a variety of ways, such as maximum rate of discharge from a source per time period, degree of removal, density of a pollutant, and permissible emissions in proportion to specific inputs or outputs of the production process. Dewess (1980) points out that while certain approaches might facilitate measurement, they may have undesirable and unanticipated implications. Limiting the concentration of a pollutant does not limit the total pollutant load. For example, limiting the density of particulates in stack gas does not necessarily reduce the total quantity discharged. Do such standards provide adequate protection over the long term?

In summary, while the ambient and emission standards appear to be reasonably stringent in relation to national standards,[1] the philosophical basis and standard-setting process raise certain questions. Current policy is to minimize emissions generally to the extent that "best practicable technology" will allow; the residual can then be dispersed, because it is believed that "the assimilative capacity of the atmosphere can be regarded as a natural resource which mankind uses for the disposal of unwanted by-products of his activities" (Alberta Environment 1980a: 1). Could this policy favor fuller utilization of this "resource" over pollution reduction? And in the even broader balancing of resource management, environment protection, and quality of life objectives, how significant is the lack of public input, particularly in the early stages of the standard-setting process?

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[1] *See Franson et al. (1982) for a detailed comparison of Alberta, B.C., Saskatchewan, Ontario, Canadian Federal and U.S. Federal Standards.*

4. ADMINISTRATION OF THE CLEAN AIR ACT

BUREAUCRATIC RESPONSIBILITIES

The Clean Air Act is administered primarily by Alberta Environment with some responsibilities being delegated to the Energy Resources Conservation Board (ERCB). Two divisions within the department's Environmental Protection Services are involved in the administration of this Act: the Standards and Approvals Division and the Pollution Control Division.

The Air Quality Branch of the Standards and Approvals Division develops ambient air quality objectives and emission guidelines for industrial and municipal facilities. It also reviews government legislation and prepares amendments where necessary. A major activity of this branch is the processing of applications from companies that require permits and licences under the Clean Air Act.

Monitoring and enforcement activities are carried out by the Air Quality Control Branch of the Pollution Control Division. This branch conducts Alberta Environment's ambient air quality and source emission monitoring program, evaluates industrial monitoring reports, and initiates enforcement action when necessary. The branch also conducts a quality assurance program for industry self-monitoring. Branch personnel investigate complaints from the public about air quality and participate in the department's Pollution Emergency Response Team (PERT). In addition, a meteorological research station is maintained in Ellerslie, Alberta.

The ERCB is responsible for managing all energy resources in Alberta. Part of its mandate is to control pollution and ensure environmental conservation throughout all development stages, from exploration through to processing and transportation of energy resources. Because almost all energy resource development proposals require not only ERCB approval but permits and licences pursuant to the Clean Air Act, close co-operation between the ERCB and Alberta Environment is essential in both the approvals and enforcement processes. Evidence of this co-operation is seen in the guidelines issued jointly by the ERCB and Alberta Environment (G-22, G-23, G-24, G-25, and G-28) which stipulate the environmental content required for certain categories of energy development applications. Environmental aspects of ERCB approvals require the additional approval of the Minister of Environment.

Certain responsibilities of the Director of Pollution Control are delegated to the ERCB with respect to natural gas processing plants and thermal electric power plants (AR 88/74, AR 89/74). These include the authority to issue directives and emission control orders and certain rights of entry and inspection. For the natural gas industry, the supervision of air quality and emissions monitoring is shared by the two agencies. Alberta Environment receives monthly reports on continuous stack emission monitoring and ambient air quality while the ERCB receives manual stack monitoring and sulphur balance reports. The ERCB conducts most of the inspection and enforcement activities for both agencies. For thermal power plants, Alberta Environment currently oversees both monitoring and enforcement although the ERCB also receives certain monitoring information.

PERMITS, LICENCES, AND CERTIFICATES OF VARIANCE

In Section 3(1) of the Clean Air Act, several kinds of industries and activities are identified as requiring a permit from the Director of Standards and Approvals before a facility may be constructed. In addition, there is a general provision that allows the Director to require a permit for any facility expected to be a source of air pollution (s. 3(1)(g)). Once constructed, these facilities require a licence for operation. The numbers of permits and licences issued during the past five years are given in Table 5. It is interesting to note the steady decline in the number of permits. The number issued in 1981-82 is almost half the number issued in 1976-77. This probably reflects the recent economic downturn and associated reduction in construction of industrial facilities in Alberta.

TABLE 5. Permits and Licences Issued Pursuant to The Clean Air Act

	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982-83
Permits	356	305	289	249	232	188	172
Licences[1]	474	441	418	365	460	576	412

[1] includes renewals

Source: *Alberta Environment, Annual Reports*

In applying for the "permit to construct," a company provides Alberta Environment with technical details of the plant design and operation including an estimate of expected stack emissions. The company commits itself to meet all environmental rules and regulations (Lack 1980: 12). The design of the plant is evaluated by the Air Quality Branch (Standards and Approvals Division) to ensure that ambient air quality objectives will be met. Deficiencies in the design are identified and discussions between the company and branch personnel ensue. For some air contaminants, such as vinyl chloride monomer, the requirements are straightforward and must be met. For other parameters, there is a certain amount of flexibility which allows companies to negotiate with the government on certain points.

An important feature of the plant design is the height of the emissions stacks. Alberta Environment outlines the method to be used for determining the appropriate stack height in its publication *Guidelines for Plume Dispersion Calculations* (see Appendix A, Section 1.9.3). The stack should be high enough to sufficiently disperse the emissions, so that ground level concentrations will remain below the ambient air quality objectives. The calculations are based upon the "method of most probable maximum concentration." For a particular stack height, the worst-case scenario is used to calculate ambient ground-level concentrations. This scenario involves:

1. maximum operating capacity of the facility,
2. lowest operating efficiency of pollution control equipment, and
3. unfavorable weather conditions (temperature inversion).

In other words, the emission rate used for calculating stack height is the highest rate that is still considered to be normal operation (Kupchanko 1982: 39). For contaminants where maximum allowable emission rates have been established through government-industry task forces (for example, for fertilizer plants and secondary lead smelters), these limits are employed in the calculations (S.L. Dobko 1983: pers. comm.). If the emission plumes from neighboring facilities overlap with that of the plant being designed, each facility is allocated a portion of the ambient guidelines.

If the calculations indicate that ambient air quality standards will not be met at ground level, then additional control technology may be required or the height of the stack may need to be increased. The strategy behind this latter adjustment is to utilize the dilution capacity of the atmosphere. The higher the stack is, the greater will be the dispersion of the air contaminants. However, although local air-quality problems may be relieved by raising the stack height, the potential for long-range transport of the contaminants is increased.

If the Director of Standards and Approvals is satisfied with the application, a permit to construct is issued. Several terms and conditions are attached to the permit. These may include the maximum production rate of the facility, the rate of release of certain air contaminants, the height of the emission stack, and other technical details. A condition is also included requiring that the ambient air quality standards in the Maximum Levels Regulation be met. Base-line monitoring of air quality prior to plant start-up may be required. The specifications attached to the permit must be incorporated into the design of the facility and construction must begin within one year of the issuance of the permit.

Once the facility has been constructed, a licence to operate is required before operations can begin. This allows Alberta Environment to consider the final design of the plant and the proposed operations. Licences to operate are issued covering a period of usually five years. This gives the licensee a period of security during which new demands for air pollution control or monitoring are unlikely unless unforeseen problems arise. The periodic renewal of the licence gives Alberta Environment the opportunity to adjust licence requirements.

The conditions of the licence with respect to stack emissions are similar to those attached to the permit to construct. However, certain details may differ and additional emission requirements may be included. In addition to emission requirements, the licence contains details about required air-quality monitoring and reporting procedures. The licence does not contain a requirement with respect to the *ambient* air quality objectives of the Maximum Levels Regulation. These objectives are considered only in the design of the plant.

The Clean Air Act provides a mechanism to temporarily exempt a company from regulations or licence requirements. A "certificate of variance" can be issued by the Minister of the Environment if the facility is going to violate a regulation or licence condition for reasons beyond the control of the owner/operator. Two necessary conditions are that the "variation" will not be detrimental to health or property and that a refusal to grant the certificate would result in serious hardship to the owner/operator without an offsetting benefit to others. Detriment to the natural environment is not an identified consideration.

Most certificates of variance are needed as a result of the accidental failure of pollution control equipment. A new emission standard may be set out in the certificate to cover the repair period. They have also been used when it was not economically feasible to upgrade an old facility.

Twenty-four certificates of variance were issued from April of 1977 to March of 1984, effective for periods ranging from a few days to two years (Table 6). All of these have since expired. These certificates concerned licensed emission levels and not other licence requirements, such as for monitoring or reporting. The regulations for particulates and visible emissions (opacity) appear to be the most common subjects of variance. Certificates have also been issued with respect to SO_2 emissions. The department considers the higher emission levels in the certificates still to be safe (S.L. Dobko

1983: pers. comm.). To further ensure this, a company may be requested to reduce production should the ground-level concentrations of a contaminant approach the ambient regulation during the period of the certificate. The certificate of variance issued to Syncrude Canada Ltd. in October, 1983, had such a condition for sulphur dioxide.

TABLE 6. Certificates of Variance Issued Pursuant to the Clean Air Act

Date	Company	Type of Plant	Location
Apr 77	Cancarb Ltd	thermal carbon black	Medicine Hat
May 77	Inland Cement Industries Ltd	cement	Edmonton
Aug 77	Alberta Power Ltd	thermal power generation	Battle River Generating Station
Nov 77	Alberta Power Ltd	thermal power generation	H.R. Milner Generating Station
Dec 77	Cancarb Ltd	thermal carbon black	Edmonton
Feb 78	Inland Cement Industries Ltd	cement	Edmonton
Feb 78	Conmac Western Industries	asphalt	ID No. 16
Mar 79	Great Canadian Oil Sands Ltd	oil sands	Fort McMurray
Apr 79	Summit Lime Works Ltd	limestone	near Coleman
May 79	Cancarb Ltd	thermal carbon black	Medicine Hat
Jun 79	Westroc Industries Ltd	wallboard	Calgary
Jul 79	Great Canadian Oil Sands Ltd	oil sands	Fort McMurray
Aug 79	Lawrence Meier Trucking Ltd	asphalt	Medicine Hat
Jan 80	Syncrude Canada Ltd	tar sands	Mildred Lake
Mar 80	Summit Lime Works Ltd	limestone	near Coleman
Sep 80	Alberta Power Ltd	thermal power generation	Battle River Generating Station
Oct 80	Coleman Collieries Ltd	coal processing	Coleman
Dec 80	Cancarb Ltd	thermal carbon black	Medicine Hat
Feb 82	Canada Cement Lafarge Ltd	cement	near Exshaw
Feb 82	Syncrude Canada Ltd	sulphur	Mildred Lake
Mar 82	Esso Chemical Canada	fertilizer	Redwater
Mar 83	Coleman Collieries Ltd	coal processing	Coleman
Jun 83	Syncrude Canada Ltd	oil sands	Mildred Lake
Oct 83	Syncrude Canada Ltd	oil sands	Mildred Lake

Source: *Certificates of Variance, Environmental Protection Services, Alberta Environment*

MONITORING

There are basically two kinds of air quality monitoring performed in Alberta: general ambient air quality monitoring and industry-related air quality monitoring. Monitoring of ambient air quality in urban and rural areas is carried out primarily by Alberta Environment. Industrial emissions and ambient air quality near a plant site are monitored by the companies themselves. Alberta Environment and the ERCB also perform a limited amount of industrial monitoring. In this section, these monitoring programs will be described.

General Ambient Air Quality

Alberta Environment operates a network of ambient air monitoring stations at various locations throughout the province. Several of these stations contribute information to the National Air Pollution Surveillance (NAPS) system. Established by Environment Canada in 1970, the purpose of the NAPS system is to provide information on the extent of air pollution in Canada and to monitor air quality trends on a national basis.

In Alberta there are six such monitoring stations, three in each of Edmonton and Calgary. Both cities have one station located in the downtown area, one in a residential area, and one in an industrial area. The addresses of these monitoring sites and the heights of the samplers are given in Table 7. The sampler intakes are located well above street level where there is adequate mixing of the air and local effects (for example, a passing bus) are avoided. Several air quality parameters are monitored continuously at these urban stations. They include total oxides of nitrogen (NO_x), nitric oxide (NO), nitrogen dioxide[1] (NO_2), ozone (O_3), total hydrocarbons (THC), carbon monoxide (CO), and sulphur dioxide (SO_2).

Edmonton and Calgary also have networks for monitoring suspended particulate matter and dustfall. Two methods are employed to measure suspended particulates. The soiling index is determined by drawing sample air through filter paper for one hour and measuring the subsequent reduction in light transmittance through the filter paper. For the second method, a high-volume sampler operates every six days and filters air for a period of 24 hours. The amount of filtered particulate matter is then determined. These samples are also analysed for benzo (alpha) pyrene and lead content. These two methods (soiling index and high-volume sampler) measure suspended particulates primarily in the size range of 0.1 to 10 microns. To measure the dustfall rate, cylinders are set out for approximately 30 days to collect settling particulates, which are generally greater than 10 microns in size.

Sulphation rate, which is a measure of sulphur compounds in the air, is monitored using exposure cylinders (or Huey plates). The gauze or tape wrapped around these cylinders is chemically treated to react with sulphur compounds in the air. They are set out for approximately 30 days, after which they are analysed to determine the amount of sulphur compounds (primarily SO_2) that reacted during the monitoring period. The locations of these cylinders in Edmonton and Calgary are given in Figures 2 and 3. Similar exposure cylinders are used to monitor hydrogen sulphide and hydrogen fluoride. Hydrogen sulphide exposure cylinders are currently being used at the three main stations in Edmonton but are no longer included in Calgary's ambient air monitoring network.

Continuous monitoring of certain air quality parameters can also be carried out in small communities and rural areas. Fort McMurray has an urban monitoring station that monitors NO_x, NO_2, O_3, SO_2, H_2S, and soiling index. This station was originally established as part of the Alberta Oil Sands Environmental Research Program. In addition, Alberta Environment has portable monitoring units in trailers that can be moved from site to site. They can be stationed in an area for a few days or several months as the need arises. There are three trailers equipped for continuous monitoring of the traditional parameters (NO_x, O_3, and so on). One of these trailers has been stationed in Fort Saskatchewan since November, 1981 and has been additionally equipped to monitor hydrogen sulphide, vinyl chloride monomer, and ammonia. The department also has four other trailers equipped to measure SO_2, H_2S, wind direction, and wind velocity. These trailers are used primarily to monitor near gas plants.

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[1] *Calculated, not monitored directly.*

Alberta Environment recently acquired a self-contained, self-powered, mobile, air monitoring laboratory that can be equipped for specific monitoring assignments. Mounted on a bus chassis, it can take air samples and measure contaminants while following pollutant flows downwind. This mobile laboratory was used to monitor SO_2 and H_2S levels during the 1982 Amoco sour gas well blowout near Lodgepole. The department has also been investigating new, sophisticated technologies for measuring trace amounts of air contaminants such as the TAGA (trace atmospheric gas analysis) system which utilizes a mass spectrometer to identify substances (Hrudey *et al.* 1983).

The department also maintains networks of dustfall collectors and exposure cylinders for total sulphation, hydrogen sulphide, and fluorides at 57 locations throughout the province. The majority of these (38) are near gas plants and the rest are near other industries (for example, fertilizer plants, cement plants) or in small urban communities.

The list of air contaminants measured throughout the monitoring network has changed little during the past decade. The actual number of stations has fluctuated slightly for some parameters, such as dustfall and sulphation. A major reduction in hydrogen sulphide monitoring occurred with the elimination of the H_2S exposure cylinder network in Calgary. This was done because monitored levels were very low and there had been no complaints of odor (W.S. Macdonald 1983: pers. comm.). As well, there has been a reduction in the number of soiling index monitors and high-volume samplers for measuring suspended particulates. These reductions have been made primarily to improve the cost-effectiveness of the monitoring network (J.C. Lack 1983: pers. comm.).

In Alberta, monitoring data are compiled and published regularly. Summaries of air quality data for Edmonton and Calgary are provided in annual monitoring reports that include data from previous years for comparative purposes. These reports also indicate how often maximum permissible concentrations of the Clean Air (Maximum Levels) Regulation were exceeded. Both the data and trend calculations are also published by Environment Canada in a report entitled *Urban Air Quality Trends in Canada, 1970-79* (Barton 1981) and in annual reports for the NAPS system.

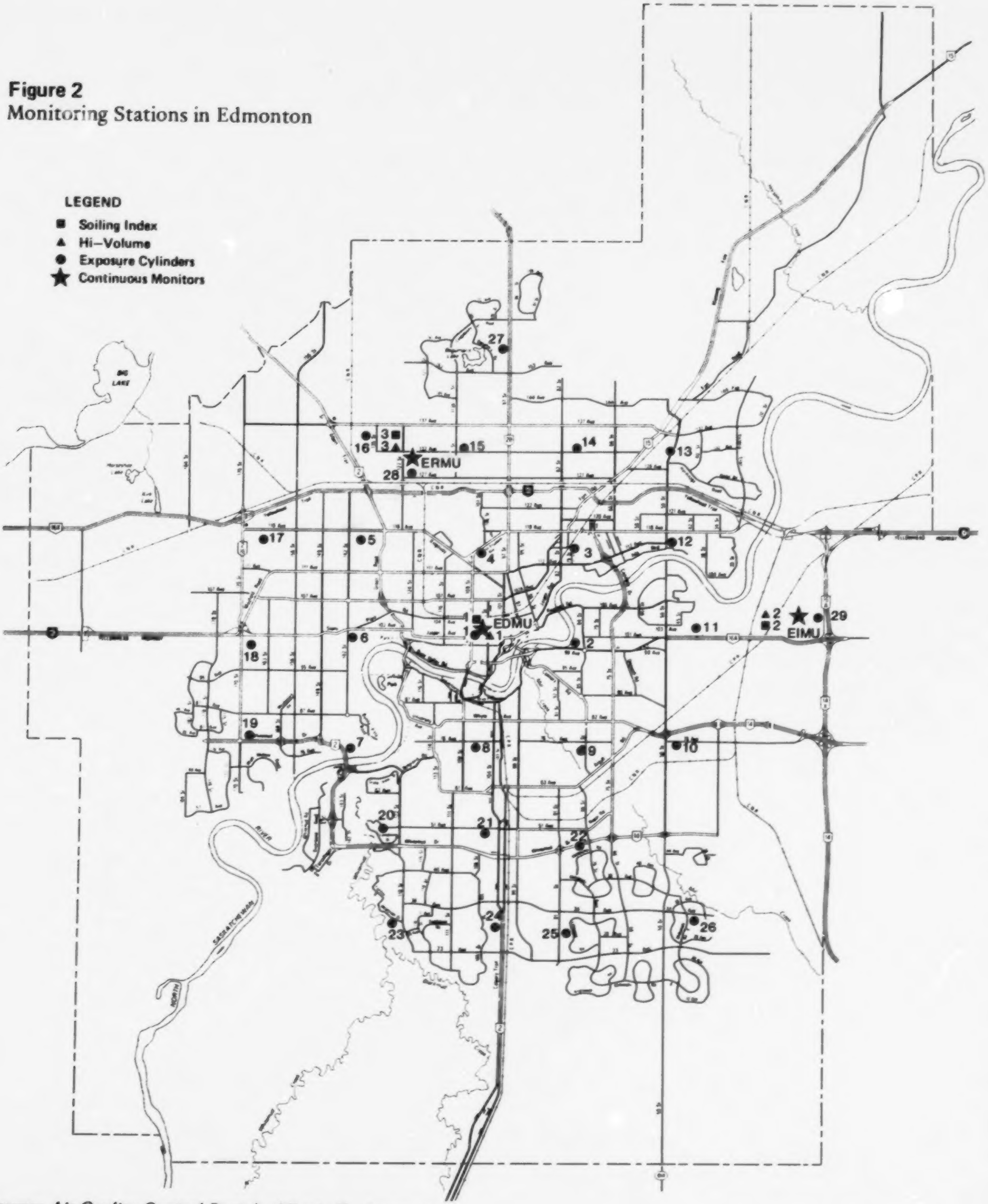
TABLE 7. Locations of Continuous Monitoring Sites in Edmonton and Calgary (height of sampler intake above ground in metres)

Calgary	Downtown	Industrial	Residential
1972	6 St & 7 Ave SW (12)	-	-
1973	"	18 A St & 45 Ave SE (3.5)	4 St & 31 Ave NW (11)
1974	"	"	39 St & 29 Ave NW (3.5)
1975	"	"	"
1976	"	"	"
1977	"	"	"
1978	4 St & 6 Ave SW (6)	"	"
1979	"	"	"
1980	"	"	"
1981	"	"	"

Edmonton	Downtown	Industrial	Residential
1972	109 St & 98 Ave (10)	-	-
1973	"	-	-
1974	"	17 St & 105 Ave (3.5)	127 St & 133 Ave (3.5)
1975	"	" (5)	"
1976	"	"	"
1977	104 St & 103 Ave (8.5)	"	"
1978	"	"	"
1979	"	"	"
1980	"	"	"
1981	"	"	"

Source: *Air Monitoring Reports, Air Quality Control Branch, Pollution Control Division, Alberta Environment*

Figure 2
Monitoring Stations in Edmonton


LEGEND
■ Soiling Index
▲ Hi–Volume
● Exposure Cylinders
★ Continuous Monitors
27
16
3
3
15
14
13
ERMU
28
17
5
4
3
12
EDMU
1
1
1
2
11
2
2
EIMU
29
6
18
19
7
8
9
10
20
21
22
23
24
25
26
BIG LAKE
NORTH SASKATCHEWAN RIVER

Source: Air Quality Control Branch, Alberta Environment

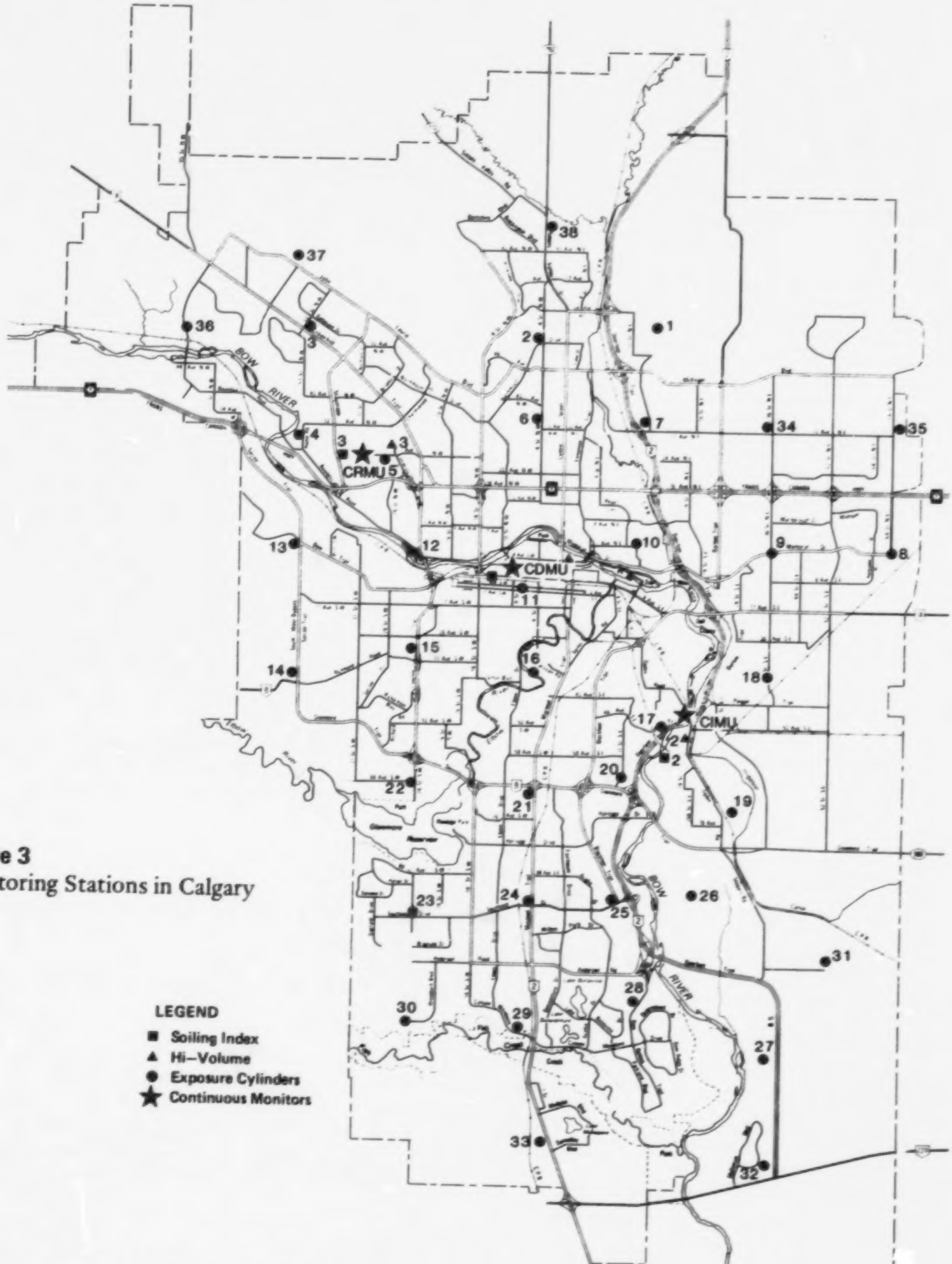

38
37
36
1
2
3
BOW
RIVER
6
7
34
35
4
3
3
CRMU
5
13
12
10
9
8
CDMU
11
15
16
18
14
17
CIMU
2
2
20
19
22
21
24
25
BOW
26
23
31
RIVER
28
30
29
27
33
32
LEGEND
■ Soiling Index
▲ Hi–Volume
● Exposure Cylinders
★ Continuous Monitors

Figure 3
Monitoring Stations in Calgary

Source: Air Quality Control Branch, Alberta Environment

In an effort to make air monitoring results more meaningful and to inform the public about existing air quality, Alberta Environment calculates and broadcasts an index of the quality of the air (IQUA) in Edmonton and Calgary (Alberta Environment n.d.a). The present index was developed in 1978 by a federal/provincial committee and introduced here in 1979. Concentrations of SO_2, NO_2, ozone, CO, and particulates at the main urban stations are adjusted to a common scale. IQUA values are calculated for each pollutant and the highest number is issued as the index. The severity of effect rises as the scale goes up: 0-25 is good, 26-50 is fair, 51-100 is poor and 101+ is very poor. Alberta Environment calculates the index twice daily from Monday to Friday. When levels rise above 50, the results are supposed to be issued more frequently (Alberta Environment n.d.a) although manpower limitations currently preclude this practice. However, there are plans to automate the system to improve the department's ability to report these incidences of air pollution (W.S. Macdonald 1983: pers. comm.). The most recent IQUA can be obtained by calling Alberta Environment in Edmonton (427-7273) and Calgary (250-2099).

Precipitation chemistry, which is closely linked to air quality, is also monitored in Alberta. Environment Canada operates the Canadian Network for Sampling Precipitation (CANSAP), which consists of 55 sampling stations throughout Canada. In Alberta, there are five CANSAP stations, located in Fort McMurray, Edson, Coronation, Rocky Mountain House, and Lethbridge. Precipitation samples are analyzed for up to two dozen parameters on a monthly basis. In addition, Alberta Environment operates a Precipitation Quality Monitoring Program that includes six monitoring stations, located in Beaverlodge, Whitecourt, Edmonton, Calgary, Red Deer, and Suffield. Monthly samples of precipitation are chemically analyzed.

Industrial Monitoring

In Alberta, many companies are required to monitor their own stack emissions and ambient air quality near the plant site. Stack emissions are monitored "continuously" and/or periodic stack surveys are performed. Continuous emission monitoring is not yet governed by a government-set performance code and should not be used to assess compliance with licence conditions and regulations (F. Witthoeft 1984: pers. comm.). Its main utility is in providing information to the department (and the company) on the operating efficiency of the pollution control equipment and indicating problems if they occur. Manual stack sampling, which may be performed once to several times per year, is governed by a performance code and can be used to assess compliance. The locations of ambient monitoring sites are based on the plume dispersion model used to determine the appropriate stack height. These locations may be adjusted if subsequent monitoring so indicates. The ambient data also can be used to evaluate the adequacy of the stack design.

Alberta Environment has a "quality assurance program" to ensure that company data are accurate and credible. For ambient monitoring, it consists of:

1. inspection and approval of the monitoring site and instrumentation
2. random calibration or observation of calibration of monitoring instruments
3. occasional inspection of the charts from monitors to confirm the results that were reported by the company
4. occasional monitoring with Alberta Environment's mobile monitoring trailers
5. sample interchange between labs for comparison purposes.

The quality assurance program for stack emissions monitoring consists of:

1. a sampling code describing acceptable techniques for manual stack sampling
2. approval of manual stack sampling procedures
3. witnessing of some company stack surveys
4. conducting stack surveys by government personnel.

Alberta Environment has a policy that company monitoring data are not used against the company in prosecutions (Kupchanko 1982: 37). This contributes to quality assurance by removing the incentive for companies to falsify data in order to avoid prosecution. However, it increases the department's workload in gathering evidence because the department must gather its own data when preparing a prosecution. The primary purpose of government stack sampling is to establish compliance or non-compliance of emissions with licence conditions and regulations.

In 1982, the stack sampling team of the Air Quality Control Branch conducted surveys of 40 emissions stacks of 16 companies. This constitutes a 43 percent increase over the previous year. They also witnessed 40 company stack surveys (Begoray 1983). The ERCB has this responsibility for natural gas plants and witnesses 20 to 30 percent of the company stack surveys in this industry (H. Thimm 1984: pers. comm.).

Not all licensed facilities are required to monitor their emissions. Some facilities, such as small chemical or gas plants, small power plants, or incinerators may produce little air pollution and may find the financial burden of a monitoring program to be excessive. For such companies, monitoring may not be required in the licence. Approximately two-thirds of the licensed facilities are not required to monitor air quality (S.L. Dobko 1983: pers. comm.).

The decision to require a small company to monitor emissions is based upon the estimated emission rate, the nature of the emissions, and other factors such as location (R.E. Beaty 1983: pers. comm.). Even if emission rates are very low, a company may be required to monitor if the facility is close to a population center or if there is some special concern or controversy.

Although a small facility may not be required to monitor, emission limits may still be included in the licence. This presents an enforcement problem because the emissions will not be checked unless Alberta Environment conducts its own stack survey. With the limited staff resources available for such surveys, sampling at these small facilities has low priority (R.E. Beaty 1983: pers. comm.).

For those companies that are required to monitor their stack emissions and ambient air quality, Alberta Environment provides detailed guidelines for the monitoring program. To this end, Alberta Environment has published several Air Monitoring Directives (AMDs). These documents outline the required monitoring and reporting procedures including instructions for sampler-site selection, instrument calibration, and presentation of data. To date, AMDs have been issued for the following industries: oil and gas, fertilizer manufacturing, pulp and paper, wood products, cement manufacturing, and power generating plants (see Appendix A, Section 1.10). For the natural gas industry, some monitoring requirements are outlined in "information letters" issued by the ERCB or jointly by the ERCB and Alberta Environment (see Appendix A, Section 3.9).

Although the monitoring procedures for several air contaminants may be described in an AMD, the operator of a facility need only monitor those contaminants specified in the licence. Furthermore, not all monitoring procedures are described in detail. Although guidelines for manual stack sampling have been set out, there are as yet no government guidelines for the instrumentation and operation of continuous stack-emission monitors. However, the development of a standardized code for continuous stack-emission monitoring has begun (W.S. Macdonald 1984: pers. comm.). Once these guidelines are in place, the Air Quality Control Branch plans to institute an inspection and auditing program for continuous emissions monitors (Begoray 1983). In the mean time, companies select their own methods for gathering this information.

Companies are required to submit their monitoring data to the Pollution Control Division in the form of monthly and annual reports. The content and format of these reports are explained in the AMDs. The monthly reports include a summary of the monitoring data, explanations for readings that exceed the Maximum Levels Regulation, and explanations for problems with air monitoring equipment. Annual reports include a summary of monthly data, consideration of long-term trends, and descriptions of alterations to the facility that may affect air quality.

In 1983, a question was raised by government lawyers concerning the government's right to release company monitoring data to the public. Following consultation with the Attorney General's department, the Minister of the Environment ordered a temporary end to the release of company monitoring data. In the mean time, he directed the drafting of new legislation to clearly permit public access to this information. On November 30, 1983, the Environment Statutes Amendment Act (Bill 92) was given royal assent. It gives the Minister the right to authorize the release of company monitoring data collected in compliance with licences under the Clean Air and Clean Water Acts. The Minister has since issued an order to authorize such a release (AR 403/84).

The procedure for reporting contraventions is outlined in the Clean Air (General) Regulations. Contraventions of ambient air quality objectives are to be reported to the Pollution Control Division within 24 hours of the incident. Although these standards are legally unenforceable, this provision ensures that the department is aware of the situation and can act appropriately. Violations of licensed stack emissions must be reported on the next working day and can be subject to legal action. A detailed written report of these violations is required within 72 hours of their occurrence. Uncontrolled or accidental emissions must also be reported in this manner.

Should several industrial facilities be located within the same area, they may be allowed to combine their efforts to monitor ambient air quality. This approach has been adopted in the industrial east end of Edmonton. The Strathcona Industrial Association presently has 11 company members. It was formed in 1973 to address concerns shared by its member companies, such as environmental monitoring and encroachment of residential development on the industrial area. In July of 1982, Alberta Environment approved their six-station network for monitoring ambient air quality. Individual companies must still monitor their own stack emissions.

ENFORCEMENT

Enforcement activities are performed primarily by the staff of the Pollution Control Division of Alberta Environment. However, for the natural gas industry, this responsibility falls to the ERCB. Although delegated authority of the Director of Pollution Control permits the ERCB to issue air quality directives and emission control orders, the ERCB asserts its authority using other Acts, such as the Oil and Gas Conservation Act. The approach to enforcement is somewhat informal; ERCB field staff usually receive good co-operation from gas plant operators in correcting environmental problems. Formal orders from the Board are rarely needed and produce a quick response by the plant operator (E. Brushett 1984: pers. comm.). The ERCB can shut down a gas plant or suspend operations and this constitutes its strongest enforcement tool, similar to a Ministerial stop order. The ERCB's power to hold a public inquiry is considered an enforcement tool as well. Prosecution is also available.

"Although the goal for compliance is 100 per cent, the enforcement program recognizes that compliance with the licence emissions limit 100 percent of the time is not practical" (Briggs 1983: 12). When contraventions do occur, Alberta Environment's reaction is tempered by consideration of the following circumstances:

i. level of emissions relative to Licence-to-Operate limits;

ii. frequency and duration of the emission;

iii. degree to which the emission was of health or environmental significance;

iv. accuracy and location of analytical equipment;

v. facility operating mode (i.e. normal, start-up/shut-down, upset or emergency conditions);

vi. ambient levels recorded during the emission period and whether or not there was any environmental damage;

vii. past performance and operating efficiency of the facility;

viii. meteorological conditions before and during the emission (i.e. inversions, wind direction, velocity, etc.);

ix. reason for the emission (i.e. emergency conditions, equipment failure, human error, upset condition, etc.);

x. location of the facility and the possibility of other source(s) causing the emissions;

xi. timeliness of reporting and implementation of short and long-term corrective measures;

xii. whether or not the corrective measures taken resulted in the least amount of emissions being discharged to the environment;

xiii. whether or not the facility is in a debugging phase or commissioning new equipment;

xiv. whether or not the facility is under an upgrading program and, if so, whether or not the upgrading program is still current;

xv. is the facility under a Directive, Control Order or Certificate of Variance? (Briggs 1983: 11-12)

Once it has been decided that enforcement action is desirable, a number of approaches can be used to secure compliance. Given in order of increasing severity, they include discussion with company officials, air quality directives, emission control orders, and stop orders. Enforcement action does not necessarily begin at the discussion level and then progress through the more stringent measures. The department can employ any of these measures if appropriate to the situation. Prosecution can also be undertaken.

Staff Discussions

Meetings between staff of the Air Quality Control Branch and staff from the offending industrial facility are held when "the emission problem is of limited environmental or health concern; the levels are just over or close to the licence requirements and guidelines; and the frequency of occurrence is low" (Kupchanko 1982: 42). Corrective action is agreed upon and a timetable is established for compliance.

Air Quality Directives

Pursuant to Section 15(3) of the Clean Air Act, a "directive" can be issued to require information from an owner or operator of a facility. Directives are issued when "co-operation falters or is too slow; the emissions are such that they may start to be of environmental concern; emissions are in excess of limits (licence or guidelines) and occur frequently; or the emissions themselves are of concern to the Department" (Kupchenko 1982: 42-43). They have also been issued on the basis of ambient monitoring data (D. Onuczko 1983: pers. comm.). Directives formally request information on past or present activities of the company with respect to air pollution but do not direct that future action be taken. For example, a directive may ask for a list of all improvements that have been made to reduce excessive emissions or the procedure that is followed when excessive emissions occur. A directive is usually accompanied by a news release. This publicizes the company's problem and shows that Alberta Environment is aware of it and is acting to correct the problem (W.S. Macdonald 1983: pers. comm.). The publicity provides additional pressure on the company to expedite corrective measures. Should a company fail to comply with a directive, Alberta Environment would probably issue an emission control order rather than prosecute on the basis of the directive (J.C. Lack 1983: pers. comm.).

Air quality directives have only recently been employed by Alberta Environment. Nine directives have been issued as of the end of March, 1984.

Emission Control Orders

An emission control order is issued by the Director of Pollution Control when emissions "are likely to have an environmental effect; may commence to have some health significance; are extremely in excess of licence or guideline requirements; are frequently over licence or guidelines levels; and where previous commitments to the Department have not been met" (Kupchanko 1982: 42). It usually is accompanied by a news release. The control order can specify certain actions to be taken by the company by a certain date. For example, control orders have been issued requiring the installation or upgrading of pollution control equipment, the performance of emission stack surveys, and the cessation of the practice of burning materials in open fires. They are also used to extend the deadlines on previous emission control orders. Failure to comply with an emission control order is an offense.

During the past 12 years (April, 1972 to March, 1984), Alberta Environment has issued 123 emission control orders (Table 8). At times, Alberta Environment has found it necessary to issue large numbers of control orders. For example, between April of 1973 and March of 1975, 54 control orders were issued. This was necessary because industries were slow to accept the cost and trouble of implementing the newly required air pollution control programs. Similarly, on March 28, 1979, Alberta Environment issued 30 emission control orders to asphalt paving plants that were slow in meeting new requirements for that industry.

TABLE 8. Enforcement Activities of Alberta Environment Pursuant to The Clean Air Act

	1972 1973	1973 1974	1974 1975	1975 1976	1976 1977	1977 1978	1978 1979	1979 1980	1980 1981	1981 1982	1982 1983	1983 1984	Total
Air Quality Directives	0	0	0	0	0	0	0	0	0	0	6	3	9
Emission Control Orders	4	28	26	4	7	8	33	2	4	1	6	0	123
Stop Orders	0	0	0	0	0	0	0	1	0	0	0	1	2
Prosecutions	0	1	1	3	2	3	4	3	0	2	6	7	32

Source: *Unpublished information, Air Quality Control Branch, Pollution Control Division, Alberta Environment*

Stop Orders

A stop order is the strongest enforcement tool available to Alberta Environment. While directives and control orders are issued by the Director of Pollution Control, stop orders require the authority of the Minister's office. Stop orders are issued when the operator of a facility has contravened or is contravening a provision of the Clean Air Act or associated regulations or orders, has failed to comply with a directive or order from the Director of Pollution Control, owns or operates a facility that is a source of air pollution that the Minister believes endangers human life and/ or property or has contravened a licence condition (Kupchanko 1982: 44). A news release usually accompanies the issuance of a stop order. Should the offender fail to comply, the Minister can get a court order to authorize someone to enter the premises and carry out the stop order. This can include shutting down the entire operation.

Two stop orders have been issued under the authority of the Clean Air Act. The first was issued on June 20, 1979 against Lawrence Meier Trucking Ltd. to shut down their Barber-Greene asphalt plant. The owner had failed to obtain a licence and was operating with inadequate pollution control equipment. The stop order was confirmed at an appeal hearing before the Environment Council of Alberta. The asphalt plant has since been properly equipped and licensed.

The second stop order was issued on October 4, 1983 against the owner of Diamond P. Arabians, a ranch in the Edmonton area. The owner had failed to act to extinguish a smoldering manure pile that had become a serious local nuisance. The stop order was not appealed.

Prosecution

There are several acts of non-compliance that can lead to prosecution. It is an offense to fail to comply with a directive, emission control order, or stop order. It is also an offense to operate without a licence; to violate a condition of a licence, permit, or certificate of variance; to provide false information in a required report; to exceed the emission standards in the Maximum Levels Regulation;

or to fail to report uncontrolled or accidental releases of an air contaminant. The Clean Air Act (s. 17) requires that prosecutions begin within two years of the offense.

The initiation of a prosecution begins with the engineers in the Air Quality Control Branch who deal with companies on a day-to-day basis. The recommendation for prosecution is considered for approval by the branch head, the Director of Pollution Control, the Assistant Deputy Minister of Environmental Protection Services, and the Deputy Minister of the department. Final approval is given by the Minister of the Environment. Once final approval is given, it is recommended to the Attorney General's department that the prosecution proceed.

Alberta Environment's enforcement officer, who operates out of the Waste Management Branch of the Pollution Control Division, then prepares a court brief for the lawyer(s). Two lawyers in the Attorney General's department handle Alberta Environment's cases; one handles cases north of Red Deer and the other handles cases for the southern part of the province. Upon examining the court brief, the lawyer(s) may indicate that more evidence is needed or may advise that the wording of the charges be modified. Following this consultation between the enforcement officer and the lawyer(s), charges are laid and the prosecution proceeds.

As of the end of March, 1984, Alberta Environment has proceeded with 33 prosecutions under the Clean Air Act (Table 9). Four of these prosecutions were unsuccessful; the others resulted in penalties ranging from a $25 to a $7,500 fine. The grounds for prosecution can be grouped into five categories (Table 10). The most common grounds are related to violations of licence conditions (usually a failure to properly operate pollution control equipment) and operating without a required licence. Only one prosecution has related specifically to emission levels (Great Canadian Oil Sands Co. in 1976). Contraventions of ambient standards are not prosecuted because it is very difficult to prove that a single specific source has caused the monitored levels.

DISCUSSION

The Clean Air Act requires two basic administrative activities: setting standards or licence conditions and enforcing them. These two functions are performed by different divisions within Alberta Environment: Standards and Approvals, and Pollution Control. This maintains the separation necessary to avoid conflicts of interest in administering the Act.

The two-stage licensing system with the initial permit to construct and subsequent licence to operate appears to provide sufficient opportunity for the department to regulate industry. The initial permit ensures that the owner/ operator is aware of the environmental requirements and incorporates them during the design and early construction phases. The renewable licence allows the government to review the adequacy of the licence conditions on a regular basis.

TABLE 9. Prosecutions Pursuant to the Clean Air Act as of March 31, 1984

Date	Defendant	Result
Early 1970s	Hudson Bay Oil and Gas	Pleaded Guilty
October, 1974	Timberline Ranch Ltd.	$25 fine
June, 1975	Peter Kiewitt	2 charges; $2,000 & $200 fine
February, 1976	National Salvage	$500 fine
April, 1976	Lawrence Meier	$25 fine
November, 1976	Great Canadian Oil Sands Co.	Dismissed
May, 1977	Town of Airdrie	$1,500 fine
September, 1977	Town of Stony Plain and County of Parkland	Dismissed
October, 1977	Houg Cement	Probation for 2 years, no fine
December, 1978	Lawrence Meier	$100 fine
December, 1978	Everall Construction	2 charges; $200 fine each
December, 1978	Kootenay Paving	$500 fine
May, 1979	CPR	2 charges; $500 fine each
October, 1979	Peter Kiewitt	$50 fine
December, 1981	Aquitaine	2 charges; $500 fine each
May, 1982	Celanese Canada	Dismissed
September, 1982	Rorison Enterprises	$1,000 fine
November, 1982	Mid Valley Construction	$1,000 fine
January, 1983	Titan Foundry	2 charges; $1,500 & $500 fine
February, 1983	CPR	$500 fine
April, 1983	A & B Rail	$100 fine
May, 1983	Cando Contracting Ltd.	$100 fine
July, 1983	Columbia Blacktop	$800 fine
September, 1983	Rorison Enterprises	$7,500 fine
November, 1983	Mayer Metals	$750 fine
December, 1983	Spiess Construction	2 charges; $500 fine each

Source: *Air Quality Control Branch, Pollution Control Division, Alberta Environment*

Alberta Environment's monitoring program for ambient air quality is relatively comprehensive in Edmonton and Calgary. Continuous monitoring of the traditional air contaminants occurs at the six urban stations and there are networks of static samplers for dustfall and sulphation rate. Considering the encroachment of Calgary's residential areas onto producing gas fields and the general public concern with respect to exposure to hydrogen sulphide, it may be advisable to re-establish a network of H_2S static samplers in Calgary.

Publication of annual monitoring reports for Edmonton and Calgary and the twice-daily IQUA index are excellent tools for providing the public with information about the quality of urban air. It appears that the public media do not take advantage of this service. Alberta Environment could promote these publications further. Not only do they disseminate information on air quality, they publicize the department's environmental monitoring activities.

TABLE 10. Grounds for Prosecutions Pursuant to The Clean Air Act

Grounds	Number of Prosecutions
Failure to report an uncontrolled or accidental emission	5
Unauthorized burning of prohibited debris	4
Operating without a licence	9
Violating a licence requirement	9
Failing to comply with an emission control order	5
Total	32

Source: *A. Reid 1983: pers. comm.*

In other urban centers, such as Lethbridge, Medicine Hat, and Red Deer, ambient air quality monitoring is irregular. There are no permanent continuous monitors as in Edmonton and Calgary. Instead, air monitoring trailers are occasionally stationed in response to complaints, special requests, or to determine the communities' air quality. A more regular program of air quality monitoring is warranted in these cities. The population of Lethbridge already exceeds 50,000 people and the city could be considered for inclusion in the federal NAPS system. A few months of monitoring every two to five years could provide insight into long-term trends in smaller communities.

Special studies of trace air contaminants have detected many trace contaminants (SCIEX 1982). In view of the wide range of contaminants present in our air, the range of parameters presently monitored seems very limited. A detailed analysis of the composition of our ambient air would be useful in ensuring that important trace contaminants are identified. Similar broad-spectrum analyses could also be used to characterize industrial emissions in detail.

In Alberta, industry is required to monitor its own emissions. This has the advantage of economic efficiency and ensures that the company is aware of its own performance and can be held fully responsible. However, there is a tendency for the public to be suspicious of industry self-monitoring. It is important that the government actively pursue its quality assurance program, including the stack sampling and witnessing program and the inspection of continuous emission monitors. In view of recent expressions of public skepticism, the department should evaluate the adequacy of this program. Perhaps if the public were more familiar with the present sytem, they would be more confident in the department's monitoring program.

It is the nature of industrial emissions to be highly variable. There are times when emissions are predictably high, for example, during start-up and shut-down. Excessive emissions can also occur unpredictably as a result of equipment failure or other unforeseen developments. Rather than set emission guidelines high enough to include these "abnormal" situations, the government has set rather stringent standards for normal operation and provides legislative direction to exempt "abnormal" situations. Although these exemptions recognize the reality of operational situations, they do have the potential to weaken public confidence in the licencing system if standards are exceeded frequently or for long periods of time.

Because industry has extensive input into the formulation of regulations and licence requirements, one would expect that these conditions are reasonable and acceptable to industry. Consequently, a very high compliance rate should be expected. However, as noted in an earier section, Alberta Environment does not expect 100 percent compliance. This acceptance of a certain amount of non-compliance leads the public to conclude that Alberta Environment is not enforcing environmental regulations (Franson *et al.* 1982, Duncan 1980). Many people consider legal prosecution to be a very important enforcement tool and yet Alberta Environment only uses prosecution as a last resort. The willingness to prosecute must be clearly established to give the government adequate leverage when negotiating with industry. The need for public education concerning other aspects of the enforcement program and for the department to be more sensitive to these concerns of the public is evident.

There are several obstacles to successful prosecution for emissions violations that relate to obtaining evidence. First of all, it is Alberta Environment's policy not to use company monitoring data for prosecution, although they do use it for other enforcement action. This hampers the department's ability to proceed with legal action. If company data indicate that emissions are exceeding air quality standards, and if Alberta Environment decides to prosecute, then the department conducts a sampling survey of its own for the purpose of gathering evidence. A second potential difficulty is that monitoring data must meet rigorous requirements to be legally effective. For example, there is a requirement for "continuity of evidence." This means that all of the steps taken during sampling and analysis must be carefully recorded and certified. There can be no opportunity for sample contamination. Alberta Environment is now following the procedure necessary for continuity of evidence when collecting evidence for prosecutions (W.S. Macdonald 1983: pers. comm.).

There is also a need for each licenced or regulated emission limit to have a clearly associated method of measurement. The need to extrapolate from monitoring data to determine compliance may lead to problems in a prosecution. For example, in the prosecution of G.C.O.S. Ltd., the court found that a monitoring device that took air samples every 12 minutes could not be used to determine contravention of a one-half hour average emission limit (Elder 1977).

In recent court cases, the defence of "due diligence" has been presented. The company charged with a pollution offense can try to establish that they did everything reasonably possible to avoid the incident. The prosecutors must be prepared to refute such a claim. The 1983 Suncor trial illustrates this and other complexities associated with a pollution trial. As government prosecutors and officials gain experience in environmental trials, these problems should diminish.

Even when the prosecution is successful, the judgments made may not provide much incentive to comply. For example, a construction company was found guilty on two charges concerning a failure to perform stack surveys on a portable asphalt plant. Although government lawyers explained that the company was saving $1,500 to $2,000 per stack survey, fines of only $500 per charge were assessed. The maximum fine available is $25,000.

In view of the difficulties associated with prosecution, it is understandable that Alberta Environment places a greater emphasis on other enforcement tools. The recent activation of air quality directives constitutes a strengthening of the department's enforcement activities at the discussion level. Nevertheless, the willingness to prosecute must be clearly established in order to provide the government with adequate leverage in the negotiating process.

Alberta's air quality control program deals much more effectively with large industrial sources of air pollution than it does with the numerous, small (but still important) sources, such as automobiles and wood-burning stoves. The responsibility for the regulation of industrial sources has been clearly accepted by the provincial government with some participation by the federal government. However, the responsibility for regulating these smaller sources is not so clearly defined. Presently, the federal government has assumed the lead role in regulating automobile emissions. Nevertheless, the air quality in Alberta cities is still adversely affected by these emissions. There is a need for other levels of government to consider more involvement in controlling these diverse sources of pollution.

The public has a definite role to play in monitoring and enforcement. Complaints to Alberta Environment concerning odor, smoke, or suspicious activities are investigated by the department and often lead to enforcement action. In view of the limited resources available to Alberta Environment for policing industrial sources, this assistance from the public is valuable. The department should encourage such participation, perhaps through a program similar to the "outdoor observer" program of Alberta Energy and Natural Resources which encourages citizens to report violations of hunting and fishing regulations. The federal Fisheries Act allows half of the fine assessed upon a polluter to be awarded directly to the plaintiff who initiated the action. These and other incentives for public involvement should be considered.

5. ALBERTA'S AMBIENT AIR QUALITY

In order to judge the success of an air quality management program, it is appropriate to examine apparent trends in ambient air quality and compare monitored levels to ambient standards. Data from Alberta Environment's ambient air quality monitoring network are presented and discussed in detail in Appendix B. Statistical analyses were not employed. Some of the main findings are summarized in this chapter.

TRENDS IN AIR QUALITY

According to the available data, there appears to have been little change in Alberta's air quality during the past decade. The only parameters that exhibit a long-term trend are related to suspended particulates. In Edmonton and Calgary, the soiling index and total suspended particulates have been increasing during the past several years. In addition, dustfall rates have risen marginally. The limited data on soiling index from Fort Saskatchewan and Medicine Hat also indicate an increase. However, no consistent increase in suspended particulates is evident from the several other Alberta communities where periodic monitoring occurs.

Many sulphur compounds in the air are derived from industrial sources. The extraction and production of oil and gas are major contributors of these air contaminants. Three forms of sulphur compounds are monitored by Alberta Environment: sulphur dioxide, hydrogen sulphide, and total sulphation rate. During the past decade, sulphur dioxide concentrations in Edmonton and Calgary have remained very low. Annual mean concentrations have remained below 0.01 ppm since 1973. Hydrogen sulphide levels and total sulphation rate have varied from year to year, but no long-term trend is evident. However, Calgary's sulphation rates in 1980 and 1981 were notably higher than in previous years.

Hydrogen sulphide and the total sulphation rate are also monitored in several smaller Alberta communities. These parameters do not appear to be changing significantly over the long term in most of these communities, although the sulphation rate in Hinton has been increasing.

Nitrogen oxides and hydrocarbons are involved in the photochemical reactions in the atmosphere that produce ozone. Both industry and automobiles are major sources of these two contaminants. Alberta Environment monitors nitrogen oxides, hydrocarbons, and ozone concentrations in Edmonton and Calgary. The annual mean concentrations have not changed significantly during the past several years. Some short-term monitoring has been done in Fort Saskatchewan, Medicine Hat, and Pincher Creek, but no changes in these three parameters are evident.

Carbon monoxide is also monitored in Edmonton and Calgary. It is emitted in greater quantities than any of the contaminants described above. Automobiles are the main source of carbon monoxide in these two cities. Highest annual average concentrations were recorded at the downtown stations. No long-term trends are evident, however. Monitoring in other Alberta communities is limited and has not identified any trends.

Alberta Environment monitors ambient fluoride concentrations near several industrial sources, such as brick and tile plants and fertilizer plants. Data from exposure cylinders indicate high fluoride concentrations near the Western Cooperative Fertilizer plant in Calgary. However, vegetation has also been monitored and does not contain excessive amounts of fluorides (L.B. Begoray 1983: pers. comm.).

COMPLIANCE WITH AMBIENT STANDARDS

Ambient air quality standards are regularly exceeded in Alberta. Since 1976, the standard for the annual mean concentration of nitrogen dioxide has been consistently exceeded at the downtown stations in Edmonton and Calgary. Because this standard is equivalent to the maximum *desirable* level of the Federal-Provincial Committee on Air Pollution (FPCAP), these high readings do not necessarily constitute a threat to health or the environment. However, the 24-hour and one-hour standards for NO_2, which are equivalent to the maximum *acceptable* levels of the FPCAP, have occasionally been exceeded as well. Nitrogen dioxide concentrations in these two cities may affect people suffering from pulmonary disorders, such as asthma (Alberta Environment n.d.b, n.d.c).

The standards for oxidants (as equivalent ozone) are also based upon the FPCAP's maximum *acceptable* levels. They are regularly exceeded in Edmonton and Calgary. These standards were frequently exceeded during the brief monitoring episodes in Fort Saskatchewan, Medicine Hat, and Pincher Creek. High natural background levels may be responsible for this high contravention rate. Nevertheless, these ozone concentrations can affect sensitive vegetation and materials as well as people with chronic pulmonary disorders (Alberta Environment 1980b, 1980c).

There have been very few occasions when the ambient air quality standards for sulphur dioxide have been exceeded. The guidelines for sulphation rate and hydrogen sulphide (exposure cylinders) have only occasionally been exceeded in Edmonton and Calgary. In some other Alberta communities, hydrogen sulphide exposure cylinders near H_2S sources have high readings more frequently.

The standards for carbon monoxide have been infrequently surpassed in Edmonton and Calgary. These standards are equivalent to the maximum *desirable* levels of the FPCAP. Occasionally the maximum *acceptable* levels are exceeded.

The contravention of ambient regulations for suspended particulates is common throughout the monitoring network. From 1979 to 1981, all stations in Edmonton and Calgary exceeded the annual standard for particulates and at some stations most of the 24-hour readings exceeded the ambient regulation. The guideline for soiling index has been surpassed more often in Calgary than in Edmonton.

The Maximum Levels Regulation of the Clean Air Act stipulates that allowance for normal background levels must be made in assessing dustfall rates. However, no procedure for determining background dustfall levels has been developed and, in practice, no allowance is made. In the annual monitoring reports for Edmonton and Calgary, unadjusted dustfall rates are compared to provincial regulations. The regulations are frequently exceeded.

Ambient guidelines for fluoride exposure cylinders are regularly exceeded near certain industrial sites, such as the Western Cooperative Fertilizer plant in Calgary and the Medicine Hat Brick and Tile plant.

DISCUSSION

According to Barton (1981), most of the contaminants monitored in the National Air Pollution Surveillance (NAPS) system across Canada decreased substantially between 1970 and 1979. However, decreases were smaller during the latter years of that period. From 1977 to 1979, the annual air quality indices of the majority of NAPS stations were classified as only "fair" (Barton 1981: 50). This may serve as a warning that Canadians have not won the long-term battle against air pollution.

In Alberta, most of the air quality parameters have remained relatively stable during the past several years. There has, however, been a slight increase in the measured quantities of suspended particulate matter. Although this poses no apparent threat to health or environment, the reasons for this trend should be identified. Does this trend result from modern construction and farming practices or increased industrial and automobile emissions, or does it simply reflect a drier Alberta climate?

Although nitrogen dioxide concentrations do not appear to be increasing, annual averages have consistently exceeded provincial regulations in Edmonton and Calgary. It is likely that they will continue to do so. Edmonton and Calgary record some of the highest NO_2 concentrations in the NAPS system. In 1980 and 1982, the annual mean NO_2 concentrations for the Calgary and Edmonton downtown stations were ranked first and second in Canada, respectively (Environment Canada 1981, Environment Canada 1983). The Alberta public is generally unaware of this unfavorable comparison. Greater awareness could increase public pressure on the government to allocate more resources to finding a solution.

Since automobiles are a major source of nitrogen oxides in these cities, some action to reduce these emissions should be taken. The setting of vehicle-emission standards traditionally lies within the jurisdiction of the federal government. However, the Alberta government can regulate vehicle-maintenance standards to ensure that emission standards are met. The control of traffic in the downtown areas is the responsibility of the municipal governments. Municipal transportation and planning departments should be encouraged to consider the impact of their activities on air quality. Clearly, a solution to this problem requires a co-ordinated effort.

A recent initiative by the federal government to reduce the lead content of automobile fuels may have implications for emissions of nitrogen oxides and hydrocarbons. It has been suggested that alcohols such as ethanol and methanol or alcohol derivatives can be used to replace lead as an octane enhancer in gasoline. Combustion of these cleaner burning fuels in automobiles would reduce the exhaust emissions (Labuda and Landheer 1983: 43). As a major producer of methanol, Alberta would also benefit economically from this development.

Ozone concentrations also exceed provincial standards with great regularity. In 1981, the annual means of the residential stations in Calgary and Edmonton ranked third and fifth in the NAPS system (Environment Canada 1982). Because ozone formation is greatly enhanced by high concentrations of NO_2, the importance of reducing NO_x emissions is further illustrated. The role of natural ozone production in Alberta also requires further study. Background levels for this province need to be determined.

Both NO_2 and O_3 levels in Edmonton and Calgary may affect people with respiratory disorders, as well as sensitive plants and materials. It would be prudent to determine what, if any, these effects actually are. There will be little improvement in this situation unless action is taken to reduce these pollution levels.

It is apparent that several ambient standards are exceeded on a regular basis. Presumably, such contraventions indicate an unsatisfactory situation. Otherwise there is no reason to have ambient air quality objectives. What, then, can be done to remedy this situation? Prosecution is very difficult when dealing with ambient air quality because it is virtually impossible to prove that a particular source is responsible for the high ambient concentrations. Usually, many sources contribute to the air pollution. One option available to Alberta Environment is to re-evaluate emission standards for troublesome air contaminants. Industrial emission standards can be modified and licence conditions for individual facilities can be adjusted. However, ambient air pollution may not be caused solely by licensed facilities. With respect to nitrogen dioxide, for example, automobiles are a major contributor. Further restrictions on industrial emitters may therefore be ineffective and unfair. Similarly, more stringent emission standards for particulates from industrial sources may have no effect on the measured amounts of particulates because industry may not be the main source of suspended particulates.

One strategy that has been employed by Alberta Environment is to relax the ambient standard for an air contaminant. This was done with the ozone regulation in 1979. Although this lowers the number of contraventions and reduces the pressure to take action, it does nothing to reduce the pollution. What is needed is further research to identify the reasons for consistently high concentrations of certain air contaminants. Alberta Environment will be conducting an inventory of emission sources in Edmonton and Calgary in 1984-85 (J.C. Lack 1984: pers. comm.). The last such inventories were conducted in 1973.

Another important research area is the health and environmental effects that are resulting from chronic, low-level air pollution. Following the Lodgepole gas well blowout, the public has become aware of the lack of knowledge concerning low-level exposure to hydrogen sulphide. Concern about the effects of ozone have also been expressed (Sage Institute 1983: 14). The increasing popularity of wood-burning stoves and fireplaces may produce an air quality problem in certain communities. Little is known about the health effects of the trace amounts of organic compounds that have been detected in our air.

Alberta Environment has been monitoring air quality for over a decade. Analysis of this information has not kept up with the accumulation of data. A new position was recently created in the Air Quality Control Branch to organize this large database and to perform more analyses. The joint government-industry Acid Deposition Research Program was initiated in 1983 to examine acid deposition in Alberta. Both biophysical and health aspects of acid deposition will be investigated. Research related to air quality has also received attention from the Research Management Division of Alberta Environment and the Alberta Environmental Research Trust. Hopefully, air-quality studies will continue to receive high priority from these research agencies.

6. OVERVIEW ISSUES

The appropriateness and effectiveness of current air quality management strategies can be assessed from several interdependent perspectives: the intent of the legislative and policy provisions, the administrative practices that implement these provisions, and the actual short- and long-term trends in air quality.

The current approach to pollution control in theory depends initially on having adequate legislation (that is, sufficiently stringent standards and penalties). If there are too many exemptions, undefined terms, or inconsequential penalty provisions, there will be little incentive for the administrators, industry, or public to take it seriously. On the other hand, the existence of strong legislation and policies does not guarantee appropriate and effective implementation. Only long-term air quality trends will be able to provide the definitive assessment of appropriateness and effectiveness.

The broad conclusion of this report is that Alberta's Clean Air Act, associated regulations, and policy documents appear to represent a reasonably tough stand against air pollution. However, the preceding chapters identify issues that warrant further public discussion. Current debate appears to be focused on various legislative ambiguities, the degree of ministerial and administrative discretion, the absence of administrative accountability with regard to enforcement practices, the lack of public involvement in policy formulation, and the appropriateness of enforcement strategies. This chapter reiterates the primary policy and implementation concerns, and identifies several broader issues regarding underlying assumptions and strategies.

POLICIES AND IMPLEMENTATION

Managing air quality in Alberta entails *developing* standards, *administering* permits and licences with the appropriate conditions attached, *monitoring* operations and emissions, and *enforcing* the legislative requirements.

The current approach to developing air quality standards has three basic elements: (1) ambient standards are established to define certain health and environmental thresholds; (2) industrial emissions standards are set within technological and economic constraints; and (3) a plume dispersion model ties the two elements together by ensuring that emissions are dispersed to the extent necessary to maintain acceptable ground level concentration requirements.

Alberta's ambient air quality standards are based primarily on federal-provincial research and the recommended objectives of the Federal-Provincial Committee on Air Pollution. Because ambient standards form the keystone of the air quality management process, it is important to question the adequacy of the scientific criteria upon which ambient standards are based. For example, do the criteria include a consideration of complex interactions among air contaminants? There is also a need for broad public input at this early policy formulation stage.

Alberta's emissions standards are developed by industry-government task forces. Best *practicable* technology, reflecting realistic economic and technological constraints, is usually recommended, except for particularly hazardous contaminants, for which best *available* technology is required. While such standards are relatively easy to administer, several commentators argue that the use of technology-based standards inhibits innovation in the search for ways to reduce emissions.

Logically, ambient and emission standards that are determined independently require a third element to link them. Dispersion calculations are made to determine the stack design necessary to dilute emissions sufficiently to maintain the required ambient levels. Such an approach raises concerns in relation to the upper limit of such dilution capacity and the implications of sending emissions elsewhere. For example, Johnston and Finkle (1983) argue that because dispersion does not reduce the total amount of pollution deposited downwind, removal and reduction techniques are the only real solution. Natural dispersion may be an acceptable short-term solution until emission control technology by itself can satisfy ambient air quality requirements. However, long-term reliance on dispersion techniques may reduce the incentive to find innovative and more ecologically acceptable means for reducing emissions.

The use of ambient standards recognizes that there are limits to the degree of contamination that can be environmentally tolerated. The eventuality of reaching those limits may be delayed if emission control performance is improved, and if enforcement of emission and ambient standards is thorough. The better the management system, the greater the environmental capacity for urban and industrial growth and development.

Ambient and emissions standards are *administered* or implemented through incorporation into the two-stage process of issuing specific permits and licences. Permits specify the ambient air quality standards which a plant must meet. This is intended to ensure that the appropriate technology is incorporated into initial project design. Licences specify maximum permissible emissions, as well as required monitoring and reporting procedures. Although this is a rational process, there are differing opinions about the appropriateness of the practice of negotiating operational technologies and conditions for each licence and then, on occasion, permitting deviation from those conditions. Given the degree of industry input into both the standard-setting and licensing processes, it is surprising that industry is not expected to accept more of the risk if licence conditions cannot be met.

Ambient air quality *monitoring* in urban areas is primarily carried out by Alberta Environment although many companies measure ambient air quality in the vicinity of their plants. Emissions are primarily monitored and reported by industry although the department conducts periodic source monitoring of certain major facilities. Concerns have been raised in this report about the adequacy of current monitoring practices with respect to the comprehensiveness of the government's ambient air quality monitoring network, particularly in communities other than Edmonton and Calgary. Given that the entire air quality management approach depends upon remaining below certain ambient levels, it is important to be assured that monitoring practices are capable of detecting all potential problem areas. Industrial monitoring requirements are extensive, but they apply primarily to major industries, which account for about one-third of all licenced facilities. Nevertheless, the question of whether the requirements for self-monitoring are sufficiently comprehensive is highly dependent upon the adequacy of the current quality assurance program, since the facilities monitored produce the bulk of industrial emissions.

While the Clean Air Act and related regulations specify numerous offenses and penalties, Alberta Environment's policy is to pursue co-operative enforcement strategies rather than prosecute. This may be explained to some extent by the difficulties associated with the litigation of environmental issues. However, not only are there apparent discrepancies between the implied intent of the enforcement provisions in the legislation and the actual administrative practices, but the pattern of continual negotiations between industry and the regulatory agencies appears less appropriate when carried through to the enforcement stage.

The public is very concerned about the enforcement of air quality standards. In 1982, a survey was commissioned by Alberta Environment to determine the environmental concerns of Edmonton residents. It showed that

> *About 9 out of 10 respondents agreed that industries which exceed air pollution standards should be prosecuted....There was a strong consensus that the government should be doing something about*

> *the problems of air pollution, that strict enforcement of air quality standards was necessary, and that this enforcement should include prosecution of polluting industries (Krahn 1983:23).*

However, "Alberta Environment believes it is not productive to enforce through the court" (Lack 1980: 19). The department argues that

> *The use of legal action should not be taken as the only criterion for measuring the Environment Management Enforcement Program....The success of the Enforcement Program to date is exemplified by the excellent condition of our environment (Kupchanko 1982:44).*

Although the limited ambient air quality data available indicate little deterioration over the last decade, the evidence that standards are being exceeded raises longer term public concerns and questions the integrity of the management strategy. Franson *et al.* suggest

> *...an information gap may be responsible for the lack of public confidence and [we] recommend that a greater effort be made to explain the enforcement process to the public and to document its successes (Franson et al.* 1982: 17).

While greater public disclosure is always to be encouraged, the real issue is that the public clearly perceives current enforcement practices to be inappropriately lenient. Thus, the need is for more open discussion with the public, as well as disclosure.

ASSUMPTIONS AND STRATEGIES

A basic assumption of current air quality management practices is that emitting certain amounts of contaminants is a right — it is just the maximum level which must be controlled. This has several implications. First, the resulting control approaches tend to look for mitigative techniques that fit comfortably within current technological, economic, and administrative constraints. This strategy does not include consideration of alternative industrial processes or even broader economic development strategy changes. Second, the human tendency is to grossly undervalue common resources like air and water, resulting in little incentive for individuals or industries to reduce emissions without government coercion. An alternate assumption — that the emission of contaminants is a privilege — could open the door to market-oriented policies since environmental damage and economics are closely related. Anderson *et al.* (1977) examine the economic, legal, engineering, and political implications of adopting an "emissions fee" approach to supplement direct regulation. They explain that the basic concept is that

> *The obligation to pay when environmental harm is produced provides an incentive not to cause that harm....While this approach requires moderately complex economic analysis to identify charge levels that will cause industry and other institutions to control environmental degradation to the desired degree, it is not impractical (Anderson et al.* 1977: 3, 5).

They provide numerous examples of the application and success of such charges in the United States and elsewhere.

The current view that the assimilative capacity of the environment is a resource to be utilized for waste disposal needs to be questioned. "Assimilation" refers to the incorporation of materials into biological systems. Although the atmosphere has a great capacity to *dilute* contaminants, its assimilative capacity is limited. Most air contaminants are simply diluted and dispersed over long distances. Although the impact of these contaminants on the environment is difficult to measure, it is important to recognize that they are not all assimilated and rendered innocuous, but contribute to the degradation of environmental quality.

Another fundamental assumption of current strategies is that if emissions are sufficiently diluted or dispersed, the pollution control problem is resolved. While local ambient air may meet required standards, this concept ignores the principle that what goes up must come down, and when it comes down it may become a land or water quality concern elsewhere. It must be recognized that the principle of dispersion trades off possible long-term ecological damage for short-term, local gain.

The lead policy of Alberta's strategy is to control pollution at its source, but it must be recognized that this is currently interpreted as industrial sources. Air quality also deteriorates because of emissions from numerous small sources such as motor vehicles. In fact, ambient air quality trends in Edmonton and Calgary identify motor vehicles as a leading source of several contaminants. The federal government adopted regulations restricting permissible emissions from new motor vehicles in 1975. Currently under review, these regulations likely will be strengthened considerably. Provincial and municipal governments could supplement these regulations by, for example, initiating a program to ensure that pollution control devices are not tampered with after purchase, and applying a lead additive tax to reverse the price differential between leaded and non-leaded fuels in favor of the latter. This would result in increased consumer demand for unleaded fuels.

The reaction of the provincial government to contraventions of industrial emissions regulations is reasonably clear. Alberta Environment or the ERCB contacts the offending company, sees that the problem is corrected, or applies some formal enforcement measure. However, the reaction of the government to contraventions of ambient air quality regulations in urban areas is virtually non-existent. Although Alberta Environment has accepted the responsibility for monitoring ambient air quality and records the contraventions, it does not react with any control measures. For example, when the air quality index in Edmonton or Calgary exceeds a certain threshold level the department simply issues the index more frequently until it falls below that level again (Alberta Environment n.d.a). It is unclear what *action* the government is prepared to take to improve the situation should the index remain unacceptably high for any substantial time period or, indeed, how "unacceptable" or "substantial" would be defined. A recent report prepared for the Alberta Branch of the Canadian Institute of Public Health Inspectors for presentation to the ERCB's public inquiry into the 1982 Lodgepole blowout raises several areas of concern in this regard (Greenwood 1983). Greenwood's analysis suggests that "there may be underlying structural weaknesses within the government's administration, weaknesses to do with the relative status of medical research connected with public safety" (Greenwood 1983: 1). Does the Provincial Board of Health have a responsibility to react to incidents of unhealthy air quality? Albertans expect the provincial government to protect our ambient air quality and so the government should clarify its approach to this problem.

Although currently there is no formal provision for public input into development of provincial objectives, standards, or guidelines, the federal Clean Air Act requires publication of National Emission Standards and specific emission standards in the Canada *Gazette*, 60 days before they come into effect. In addition, the federal Department of Environment's policy for public consultation and information availability is attempting to achieve a

> *...new approach to regulation-making...designed to encourage and better utilize the public's views and perceptions. Specifically, it is designed to: open the regulation making process to public scrutiny; provide the public with an effective opportunity to contribute in the context of an explicit procedure; structure the various contributions in an efficient and fair manner and, where necessary, incorporate the government requirement for a Socio-Economic Impact Analysis (Canada 1981:83).*

Consideration of similar measures in Alberta may help to resolve public concerns regarding public involvement in current air quality management practices. Indeed, given that Alberta's air quality standards are comparable to other jurisdictions in Canada, increased public scrutiny should be welcomed. The best way to resolve current concerns and maintain the leading edge in the development and application of more effective and efficient policy directions is to open the processes to public scrutiny and involvement.

The introduction of this report suggests that air quality is a fundamental measure of the ecological soundness of our growth and development. Our ability to evaluate our basic assumptions and to strive for pro-active rather than reactive policies is a fundamental measure of our maturity as a society.

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APPENDIX A

ANNOTATED BIBLIOGRAPHY OF LEGISLATION AND POLICIES RELATING TO AIR QUALITY IN ALBERTA

1. Provincial Clean Air Act and Associated Regulations and Policies

1.1 Clean Air Act
1.2 Clean Air Regulations
1.3 Clean Air (General) Regulations
1.4 Clean Air (Maximum Levels) Regulation
1.5 Stop Order Appeal Regulations
1.6 Natural Gas Processing Plant Delegation Regulations
1.7 Thermal Electric Power Plant Delegation Regulations
1.8 Release of Monitoring Information Order Regulation
1.9 Guidelines and Standards
1.10 Air Monitoring Directives

2. Federal Clean Air Act and Associated Regulations and Policies

2.1 Clean Air Act
2.2 Motor Gasoline Related Regulations
2.3 Secondary Lead Smelter Related Regulations
2.4 Metallurgical Industries Related Regulations
2.5 Asbestos Mining and Milling National Emission Standards Regulations
2.6 Chlor-Alkali Mercury National Emission Standards Regulations
2.7 Fuels Information Regulations
2.8 Vinyl Chloride National Emission Standards Regulations
2.9 Ambient Air Quality Objectives
2.10 Emission Guidelines

3. Related Provincial Legislation and Policies

3.1 Environment Council Act
3.2 Department of the Environment Act
3.3 Land Surface Conservation and Reclamation Act
3.4 Land Conservation Regulations
3.5 Oil and Gas Conservation Act
3.6 Oil and Gas Conservation Regulations
3.7 Oil Sands Conservation Act
3.8 Hydro and Electric Energy Regulation
3.9 ERCB Interim Directives, Information Letters, Guidelines, and Reports
3.10 Planning Act
3.11 Subdivision Regulation
3.12 Rural Industrial Land Use Policy

1. Provincial Clean Air Act and Associated Regulations and Policies

1.1 Clean Air Act, RSA 1980, c. C-12 and amendments up to January 1, 1985

Section 1(a)	"air contaminant" means any solid, liquid, or gas or combination of any of them in the atmosphere resulting directly or indirectly from the activities of man (people).
Section 1(b)	"air pollution" means (i) the presence in the atmosphere of any air contaminant in excess of the permissible concentration prescribed in the regulations for that air contaminant, or (ii) the presence of any air contaminant having an offensive odor in the atmosphere, regardless of its concentration in the atmosphere.
Section 2(1)	enables the Minister to make regulations prescribing: maximum permissible concentrations of air contaminants; calculated at ground level; allowed to be emitted from a source; rate of emission; measurement criteria.
Section 2(3)	any maximum permissible concentration of an air contaminant prescribed by regulations pursuant to this section must conform to those prescribed under the Provincial Board of Health regulations for the same contaminant for the same part of Alberta.
Section 2(4)	regulations pursuant to Section 2(1) may incorporate documents which set standards relating to: air quality; preventing and controlling air pollution; design, construction, maintenance, or operation of a possible source of air pollution.
Section 3(1)	a permit from the Director of Standards and Approvals is required to construct plants to manufacture petroleum products, natural gas products, and generate thermal electric power, among others.
Section 3(12)	construction of a plant without a permit or in contravention of a permit is an offence.
Section 4	a licence to operate facilities identified in Section 3 is required from the Director of Standards and Approvals.
Section 4(8)	operation of a plant without a licence or in contravention of the licence is an offence.

Section 10	enables the Minister to issue a "certificate of variance" to vary the terms of a permit, licence, or requirements of the regulations.
Section 11	the Minister may issue a certificate of variance if the applicant's problems result from factors beyond his control, if it is not likely to result in air pollution detrimental to life or health or adversely affect property, or if refusal would result in serious hardship to the applicant without offsetting benefits to others. contravention of the Certificate of Variance is an offence.
Section 13(1)	the Director of Pollution Control may issue emission control orders if she/he determines that there exists an air contaminant: in concentrations exceeding maximum permissible concentrations; in concentrations exceeding maximum permissible calculated ground level concentration; exceeding maximum visible emissions permitted; has an offensive odour; or is likely to be detrimental to life or health or to adversely affect property.
Section 13(2)	if a licence has been or is about to be contravened, the Director of Pollution Control may issue an emission control order.
Section 13(3)	an emission control order may: (a) limit or control the rate of emission of a contaminant (b) order the stopping of emission of a contaminant permanently or for a specified period (c) require compliance with directions relating to procedures to be followed (d) require equipment installation or repair (e) require measurement of rate of emission and/or ambient concentration.
Section 13(9)	non-compliance with an emission control order is an offence.
Section 14(1)	the Minister may issue a "stop order" if the Act or regulations or conditions of a licence are contravened or if any plant, structure, or thing is a source of air pollution of immediate danger to human life or property.
Section 14(2)	a stop order may (a) require cessation of the specified contravention (b) stop any operations permanently or for a specified period.
Section 14(4)	failure to comply with a stop order is an offence which may

	result in a fine not exceeding $50,000 per day or imprisonment for up to 12 months, or both.
Section 14(7) and (8)	a person receiving a stop order may appeal to the Minister who shall refer it to the Environment Council of Alberta for an inquiry.
Section 14(12)	Section 14 applies whether or not the contravention of the Act, regulation, or order constitutes an offense, and whether or not there has been a conviction for an offense.
Section 15(1)	enables an authorized person to enter premises to investigate anything that is, or contains, a source of air pollution.
Section 15(2)	failure to permit such investigation may result in the authorized person applying to the Court of Queen's Bench for an order enforceable by a sheriff.
Section 15(3)	may direct provision of records of information relating to the emission of air contaminants.
Section 15(4)	failure to comply with a direction to provide specified information is an offence which may result in a fine not exceeding $5,000 per day.
Section 15.2	requires the Director of Pollution control to release monitoring data submitted to the government by a licence holder to the public, should the Minister so order.
Section 15.3	submitting false or inaccurate information in reports required by the government is an offense.
Section 16	offences under this Act for which no penalties have been specified may result in a fine not exceeding $25,000 and, in default of payment, to a prison term not exceeding three months.
Section 17	prosecution under the Act must commence within two years of the commission of the alleged offence.
Section 20(4)	requires a licence from the Director of Standards and Approvals for operation of a plant under the Oil and Gas Conservation Act or the Hydro and Electric Energy Act.

1.2 Clean Air Regulations, AR 33/73 and amendments up to January 1, 1985

Pursuant to Section 10 of the Clean Air Act (now Section 18 of the Clean Air Act, RSA 1980 c. C-12)

Part 1. Application for a Permit to Construct a Plant (Sections 3-6)

Section 3	requires a permit issued by the Director of Standards and Approvals to construct a plant.
Section 4	specifies information required for an application to construct a plant.

Part 2. Application for a Licence to Operate or Use a Plant (Sections 7-12)

Section 7	requires a licence issued by the Director of Standards and Approvals to operate or use a plant.

Part 3. Application for an Amendment to a Permit (Sections 13-17)

Part 4. Application for an Amendment to a Licence (Sections 18-20)

Part 5. Application for a New Licence (Sections 21-23)

1.3 Clean Air (General) Regulations, A.R. 216/75 and amendments up to January 1, 1985

Pursuant to Section 10 of the Clean Air Act (now Section 18 of the Clean Air Act, RSA 1980, c. C-12)

Section 1(d)	"prohibited debris" means any inflammable debris that when burned may result in dense smoke, offensive odors, or toxic air contaminants (including a long list of specific materials).
Section 2(1)	exempts from complying with Sections 4, 4.1, and 4.2 of the Act: municipal sewage treatment plants (except where digester gases are flared), specified meat packing plants, specified thermal electric power generating plants, and portable incinerators with a burning capacity of 200 pounds per hour.
Section 4	enables the Department of the Environment to publish guidelines and standards for the construction and operation of any plant.
Section 5	prohibits release of toxic air contaminants to the atmosphere unless written approval of the Director of Standards and Approvals has been obtained.

Section 6	requires written approval of the Director of Standards and Approvals to make an open fire for burning prohibited debris.
Section 8	requires compliance with specifications of Sections 10 and 11 of the Clean Air (Maximum Levels) Regulations (re visible emissions and opacity).
Section 9(1)	requires compliance with Section 12 of the Clean Air (Maximum Levels) Regulations (re particulate emissions).
Section 9(2)	prohibits use of any device which dilutes or otherwise conceals the concentration of particulates in an effluent stream.
Section 10	contravention of Sections 5, 6, 8, or 9 is an offence which may result in a fine not to exceed $1,000 per day.
Section 12	requires reporting of uncontrolled, unauthorized, or accidental releases of air contaminants to the Director of Pollution Control within 24 hours of its discovery and a written report within 72 hours.
Section 13	contravention of Section 12 is an offence which may result in a fine not to exceed $1,000 per day.

1.4 Clean Air (Maximum Levels) Regulation, A.R. 218/75 and amendments up to January 1, 1985

Pursuant to Section 3 of the Clean Air Act (now Section 2 of the Clean Air Act, RSA 1980, c. C-12)

Section 1(f)	"effluent stream" means the combination of one or more air contaminants in a gaseous medium emitted by or from a plant.
Section 1(h)	maximum permissible concentration means the maximum permissible concentration of an air contaminant at the point of measurement.
Section 1(i)	"particulates" means any material, except uncombined water, having definite physical boundaries at standard conditions.
Section 1(m)	"standard conditions" means a temperature of 25 degrees Celsius and a barometric pressure of 760 millimeters of mercury.
Section 1(n)	"stationary source of air pollution" means (i) a plant, structure, or thing referred to in Section 4 of the Act (ii) a plant, structure, or thing specified as being subject to

Section 4 of the Act

(iii) any building, structure, facility, or installation therein which emits or may emit air contaminants.

Part 1. Maximum Permissible Concentration of Air Contaminants in the Ambient Air (Sections 2-8)

Specify maximum permissible concentrations of air contaminants in ambient air for:

- sulphur dioxide
- hydrogen sulphide
- nitrogen dioxide
- carbon monoxide
- oxidants as equivalent ozone
- suspended particulates
- total dustfall readings

Part 2. Visible Emissions (Sections 9-11)

Section 9(1)	"observer" means a visible emission reader who is the holder of a Certificate of Proficiency issued under Subsection 3. "opacity" means the degree to which visible emissions obstruct the passage of light as determined by an observer. "visible emissions" means any air contaminants which, when emitted into the atmosphere, can be detected by an observer but does not include an open smokeless flame.
Section 10(1)	maximum visible emissions permitted shall not exceed an opacity of 40 percent averaged over a period of six consecutive minutes.
Section 10(2)	provides exemption from Subsection 10(1) for start-up or shut-down, soot blowing or process purging, and rapping of electrostatic precipitators for specified periods.
Section 10(3)	provides further exceptions from Subsections 10(1) and 10(2) for a specified list of activities.
Section 11	opacity can only be determined by an "observer" who shall average 24 consecutive readings taken over a period of six consecutive minutes at 15 second intervals.

Part 3. Particulate Emissions — General (Sections 12-12.4)

Section 12(1)	exempts a list of specific activities from this section.
Section 12(2)	establishes detailed permissible concentrations of particulates

	in an effluent stream to the atmosphere.
Section 12.1	establishes detailed permissible concentrations of particulates emitted to the atmosphere from a secondary lead smelter. "secondary lead smelter" means any plant or factory in which lead-bearing scrap or lead-bearing materials, other than lead-bearing concentrates derived from a mining operation, are processed by metallurgical or chemical process into refined lead, lead alloys, or lead oxide.
Section 12.2	provides specific lengths of time the particulate emission standards prescribed in Section 12.1 may be exceeded by certain secondary lead smelting activities.
Section 12.3	stipulates requirements for stack sampling surveys of secondary lead smelters, including departmental witnessing.
Section 12.4	all atmospheric monitoring for lead or lead-bearing particulates from a secondary lead smelter must conform with the licence and consist of high volume sampling technique, per Environment Canada Report EPS-1-AP-75-4 *Standard Reference Method for the Determination of Lead in Airborne Particulates (Atomic Absorption Spectrophotometry)*.

Part 3.1. Gaseous Emissions — Vinyl Chloride and Polyvinyl Chloride Plants (Sections 12.5-12.8)

Section 12.5	"fugitive emission" means the presence of vinyl chloride in an effluent stream from any plant source including loading and unloading lines, pumps, compressor and agitator seals, pipe joints, open vessels, process wastewater, laboratory fume hood vents and building ventilation but excluding flues, stacks, vent pipes, reactors, and strippers.
Section 12.6	stipulates permissible concentrations of vinyl chloride in an effluent stream to the atmosphere.
Section 12.7	stipulates survey requirements to determine vinyl chloride quantity or concentration and the corresponding operating unit production rate or plant production rate.
Section 12.8	stipulates requirements for monitoring the atmosphere in the vicinity of a vinyl chloride or polyvinyl chloride plant for the presence of vinyl chloride (must consist of at least one 24-hour average vinyl chloride concentration determination in every consecutive 24-hour period).

1.5 Stop Order Appeal Regulations, A.R. 9/74

Pursuant to Section 17 of the Department of the Environment Act, Section 11 of the Land Surface Conservation and Reclamation Act (now Section 9 of the Land Surface Conservation and Reclamation Act, RSA 1980 c. L-3), Section 10 of the Clean Air Act (now Section 18 of the Clean Air Act, RSA 1980 c. C-12), and Section 10 of the Clean Water Act (now Section 21, Clean Water Act, RSA 1980, c. C-13).

Section 3	a person has 15 days after service of a stop order to serve the Minister with an Appeal.
Section 4	the Minister has 15 days to refer the Appeal to the Environment Conservation Authority (now Environment Council of Alberta).
Section 5	the Authority shall hold a hearing, prepare a report of its findings, and make recommendations regarding confirmation, amendment, or revocation of the stop order to the Minister.

1.6 Natural Gas Processing Plant Delegation Regulations, A.R. 88/74

Pursuant to Section 5 of the Clean Air Act (1971) (now Section 12 of the Clean Air Act, RSA 1980, c. C-12)

Section 2	with respect to natural gas processing plants, designates the Energy Resources Conservation Board as a Government agency which shall exercise the same power and authority as the power of the Director of Pollution Control under Sections 6 and 8 (now Sections 13 and 15) of the Clean Air Act.

1.7 Thermal Electric Power Plant Delegation Regulations, A.R. 89/74

Pursuant to Section 5 of the Clean Air Act (1971) (now Section 12 of the Clean Air Act, RSA 1980, c. C-12)

Section 2	with respect to thermal electric power plants, designates the Energy Resources Conservation Board as a Government agency which shall exercise the same power and authority as the power of the Director of Pollution Control under Sections 6 and 8 (now Sections 13 and 15) of the Clean Air Act.

1.8 Release of Monitoring Information Order, A.R. 403/84

Pursuant to Section 15.2 of the Clean Air Act, RSA 1980, c. C-12

Section 1	the Director of Pollution Control shall release stack emission or ambient monitoring information to an applicant following

receipt of the completed request form as presented in the Schedule.

1.9 Guidelines and Standards

1.9.1 Alberta Environment, Standards and Approvals Division. February 1976.

Guidelines for Limiting Contaminant Emissions to the Atmosphere from Fertilizer Plants and Related Industries in Alberta. 23 pages.

These guidelines were developed in co-operation with the fertilizer industry and are based on "best demonstrated technology." Contaminant emission limits are considered to be compatible with what has proven to be achievable elsewhere. The guideline delineates separate emission limits for new and existing plants. A two-stage reduction program is presented for existing plants. The first stage involves process modifications not requiring major capital outlays and should be achieved by January 1, 1978. The second stage involves obtaining new plant guideline levels by January 1, 1981. Alberta Environment acknowledges they have made no economic assessment of the proposed changes; however, they point out that the limits they propose are justified economically by many of the states in the U.S. which have initiated similar limits.

Specific permissible emission levels are established for sulphuric acid, nitric acid, phosphoric acid, ammonium phosphate, ammonia, and prilling tower plants. Specific process modifications and improvements are recommended.

1.9.2 Alberta Environment, Standards and Approvals Division. March 1977.

Environment Control Guidelines for Asphalt Paving Plants. 18 pages.

These guidelines were developed in conjunction with the Alberta Road Builders Association. All permits and licences for asphalt paving plants under the Clean Air Act are contingent upon the effective control of odorous, gaseous, and particulate discharges. While dust is the predominant contaminant released in the atmosphere by asphalt paving plants, they also discharge carbon monoxide, oxides of sulphur, oxides of nitrogen, hydrocarbons, water vapor, and odorous compounds. The guidelines reiterate the requirement for these plants to achieve the allowable ambient concentrations of air contaminant specified in the Clean Air (Maximum Levels) Regulation. The guidelines also require asphalt paving plants to undertake two stack surveys on each dryer or dust collector stack to determine the level of particulate emissions. If the results comply with the regulation, sampling frequency will be reduced to one survey per year.

1.9.3 Alberta Environment, Standards and Approvals Division. May 1980.

Guidelines for Plume Dispersion Calculations. 112 pages.

The guidelines state that "the assimilative capacity of the atmosphere can be regarded as a natural resource which mankind uses for the disposal of unwanted byproducts of his activities." These guidelines are based on a recognition of a finiteness of the air resource and the necessity for managing it wisely. The intent is to ensure that quantities of pollutants emitted into the atmosphere are kept as low as best practicable technology will allow and that the residual waste is discharged so as not to overtax the air resource. Factors contributing to decisions regarding requirements for stacks include:

- industrial plant operations, immediate and projected
- land use, present and future
- population density, present and future
- air traffic
- aesthetics
- other pollutant sources
- aims, needs, and wishes of the populace.

The set of formulas and rules for stack design proposed by Alberta Environment's Prescribed Methods are based on relatively simple calculations that are known to design stacks such that ambient concentrations are generally well below the air quality objectives. Alberta Environment's rationale for using the prescribed methods is:

- to simplify and expedite the approval process;
- to provide small industrial facilities with specific design information so that they don't have to incur a large expense for data collection and analysis; and
- to facilitate identification of potential problem areas.

However, Alberta Environment recognizes that stacks designed to conform with the prescribed methods may not always be adequate given unique circumstances of topography or climate. Minimum designs may save money for the company in the short term but lead to costly corrective actions in the future. Indeed, Alberta Environment indicates that they examine the total picture and require that corrective action be taken (even though original stacks may be designed in accordance with prescribed methods) if an unacceptable frequency of pollutant concentrations in excess of air quality objectives occurs, if vegetation is damaged or there are other undesirable environmental effects, or if there are complaints from local residents.

1.9.4 Alberta Environment, Standards and Approvals Division. 1984.

Emission Guidelines for Fossil Fuel Fired Thermal Power Generating Plants in Alberta. 18 pages plus appendices.

These guidelines for new fossil fuel fired thermal powered generating plants specify emission limits for particulate matter, oxides of nitrogen (NO_x), and sulphur dioxide (SO_2). All sources not covered under these guidelines are subject to existing regulations. The emission limits are based on the best technological system of continuous emission reduction, taking into account cost, health and environmental impacts, and energy requirements. Surveys are required in order to determine the compliance with limits, and are based upon a one hour averaging period for particulate matter, oxides of nitrogen, and sulphur dioxide. Continuous (source emissions) monitoring systems (CMS) are also required for nitrogen oxide, sulphur oxide, oxygen, or carbon dioxide, and opacity. Ambient air quality requirements are those specified in the Clean Air (Maximum Levels) Regulation. These guidelines also specify procedures for determining compliance, and recording requirements for source emissions monitoring.

The guidelines define "available systems capacity" to mean the capacity determined by subtracting the system load on the system energy reserves from the net system capacity. An "emergency condition" refers to a period when the electrical generation output cannot be reduced because of various system requirements, when the electric generation demand is being shifted, or when the portion of the facility with the malfunctioning flue gas desulphurization system is the only unit available to maintain the company's system emergency reserves. A "malfunction" means partial or complete breakdown of equipment due to factors beyond the control of the operator.

The requirements are phrased as "should" rather than "shall."

1.9.5 **Alberta Environment, Standards and Approvals Division.** August 1982.

Guidelines for the Location of Stationary Bulk Ammonia Storage Facilities. (First issued May 1977.) 9 pages.

These guidelines establish minimum distance recommendations for the location of new stationary ammonia storage facilities. The guidelines are intended to ensure the elimination of the possibility of the public becoming exposed to harmful concentrations of ammonia. Normal operations of an ammonia storage facility should not result in any emissions, but the guidelines propose various safety precautions to prevent accidents or vandalism.

1.9.6 **Alberta Environment.(n.d.)**

Incinerator Standards. 15 pages.

These standards outline the principles of incineration designed to enable disposal without contributing excessively to air pollution. All incinerators except those which serve a single-family residence must be constructed under a permit and operate under a licence. The permit and licence must meet the requirements of the Clean Air Act. Thus these standards present information regarding the sizing classification method of estimating loading, and the design requirements of incinerators.

1.10 Air Monitoring Directives

AMD-81-1 Oil and Gas Industry

- pursuant to Section 4 and 11 of the Clean Air (General) Regulations, A.R. 216/75.
- only those portions pertaining to specific terms, conditions, and requirements of each Licence-to-Operate need to be taken into consideration.
- intended to be used by oil sands and heavy oil production plants, petroleum refineries, and sour gas processing plants.
- requires an annual report, notification of uncontrolled releases, and notification of non-compliance with any licence condition or regulation (violation).
- emphasizes air quality assessment in annual reports by stressing common analysis procedures and quality assurance over airshed regions.
- requires monthly reports which document summarized data, check for data quality control, and document process problems.
- requires violation reports and reports of uncontrolled or accidental releases which identify need for immediate corrective or follow-up action.

AMD-80-1 Pulp and Paper Industry

- similar approach to above.

AMD-79-1 Fertilizer Industry

- similar approach to above.

AMD-79-4 Cement Manufacturing Industry

- similar approach to above.

AMD-77-1 Power Generating Industry

- similar approach to above.

AMD-77-2 Wood Products Industry

- similar approach to above.

2. Federal Clean Air Act and Associated Regulations and Policies

2.1 Clean Air Act, SC 1971, c. 47.

Section 2(1)(a)	"Air contaminant" means a solid, liquid, gas or odor, or a combination of any of them that, if emitted into the ambient air, would create or contribute to the creation of air pollution.
Section 2(1)(b)	"Air pollution" means a condition of the ambient air, arising wholly or partly from the presence therein of one or more air contaminants, that endangers the health, safety, or welfare of persons, that interfers with normal enjoyment of life or property, that endangers the health of animal life, or that causes damage to plant life or to property.
Section 2(1)(c)	"Ambient air" means the atmosphere surrounding the earth but does not include the atmosphere within a structure or within any underground space.
Section 2(1)(i)	"National ambient air quality objective" means any such objective prescribed by the Governor in Council pursuant to Subsection 2 of Section 4 and the terms "maximum tolerable limit," "maximum acceptable limit," and "maximum desirable limit" refer, respectively, to the maximum concentration within the range that is the national ambient air quality objective.
Section 2(1)(l)	"Stationary source" means any source of emission of one or more air contaminants other than a motor vehicle, ship, train, or aircraft.
Section 3(1)	enables the Minister to: (a) establish, operate, and maintain a system of air pollution monitoring stations throughout Canada. (b) collect data on air pollution in Canada and process, correlate, and publish such data on a regular basis. (c) conduct research and studies relating to the nature, transportation, dispersion, effects, control, and abatement of air pollution. (d) formulate comprehensive plans and designs for the control and abatement of air pollution. (e) publish information which would inform the public about all aspects of the quality of the ambient air and the control and abatement of air pollution.
Section 3(2)	enables the Minister to co-operate with the government of any province in establishing a system of air pollution monitoring

	stations throughout Canada.
Section 4(1)	enables the Minister to formulate, with respect to any air contaminant, ambient air quality objectives reflecting three ranges of quality of the ambient air for short-term or long-term conditions identifying (a) the tolerable range of concentrations (b) the acceptable range of concentrations (c) the desirable range of concentrations.
Section 4(2)	enables the Governor in Council to prescribe as national ambient air quality objectives any objectives formulated by the Minister pursuant to Subsection 1.
Section 5	enables the Minister to consult with representatives of industry and labor, provincial and municipal authorities, and other persons interested in any aspect of the ambient air or the control or abatement of air pollution.
Section 5(2)	enables the Governor in Council to establish advisory or other committees to advise the Minister.
Section 6	enables the Minister to require that information be provided by any operator of any work which the Minister has reasonable grounds to believe results in the emission of air contaminants.
Section 7	enables the Governor in Council to prescribe national emission standards, establishing the maximum quantities and concentrations of air contaminants where such contaminants would (a) constitute a significant danger to the health of persons or (b) be likely to result in violation of a term of any international obligation relating to the control or abatement of air pollution.
Section 7(2)	requires publication of any proposed national emission standard in the Canada *Gazette* and a 60-day waiting period.
Section 9	prohibits contravention of emission standards.
Section 11(1)	enables the Minister, where national ambient air quality objectives have been prescribed, to recommend specific emission standards for specific federal undertakings within any geographical area.
Section 11(2)	such specific emission standards shall take into account

	(a) the rate of emission and total quantity emitted into the ambient air from other sources of air contaminant emission in the geographical areas (b) the best available technology for control of air pollution.
Section 12	enables the Minister, with respect to any federal work where national ambient quality objectives have not been prescribed to recommend specific emission standards based on the best available technology for control of air pollution and based on such factors, including the cost of complying with the standards, as the Minister considers appropriate.
Section 13(1)	enables prescription of specific emission standards pursuant to Sections 11 and 12.
Section 13(2)	requires publication of proposed specific emission standards.
Section 13(3)	enables the Minister to consult with officers of departments operating federal works where the Minister proposes to formulate specific emission standards.
Section 14	enables the Governor in Council to make regulations relating to the composition of fuels.
Section 15	enables an inspector to require plans and specifications as will enable him to determine the quantity and concentration of air contaminants likely to be emitted from the construction of any federal works.
Section 17	enables an inspector to order a federal work to discontinue.
Section 19	enables the Minister to enter into agreements with provinces regarding the control and abatement of air pollution.
Section 22	prohibits the production, use, or sale in Canada of any fuel that contains elements or additives exceeding a specified concentration.
Section 23	enables the Governor in Council to make regulations prescribing maximum concentrations of any element in fuel.
Section 31	enables the Governor in Council to make regulations (a) prescribing substances and classes of substances, and quantities and concentrations of substances, in air deemed to be air contaminants (b) prescribing the nature of information requested by the Minister

	(c) respecting the method of analysis of samples of material emitted into the ambient air.
Section 33(1)	contravention of emission standards is an offence which may result in a fine not exceeding $200,000 for each offence.
Section 33(2)	violation of Section 22 referring to fuels is an offence which may result in a fine not exceeding $5,000 for each offence.
Section 33(3)	violation of an order to cease operation pursuant to Section 17 is an offense which may result in a fine not to exceed $5,000 for each offence.
Section 41	requires the Minister to prepare an annual report on the operations under this Act.

2.2 Motor Gasoline Related Regulations

2.2.1 Lead-Free Gasoline Regulations, SOR/73-663

Pursuant to Section 23 of the Clean Air Act, SC 1971, c. 47.

These regulations prescribe, for the purposes of Section 22 of the Clean Air Act, the maximum concentrations of lead in lead-free gasoline and of phosphorous in phosphorus-free gasoline.

Section 2	commencing July 1974 the maximum concentration of elemental lead in gasoline represented as lead-free or as having had no lead added during the production process shall be .06 grams per imperial gallon as measured in accordance with the atomic absorption method.
Section 3	commencing July 1974 the maximum concentration of elemental phosphorus in gasoline represented as phosphorus-free or as having had no phosphorus added during the production process shall be .006 grams per imperial gallon as measured in accordance with the zinc oxide colorimetry method.

2.2.2 Leaded Gasoline Regulations, SOR/74-459

Pursuant to Section 23 of the Clean Air Act, SC 1971, c. 47.

These regulations prescribe, for the purposes of Section 22 of the Clean Air Act, the maximum concentration of lead in gasoline to which lead has been added during the production process and the submission of information relating thereto.

Section 2	commencing January 1976 the maximum concentration of lead in gasoline to which lead has been added during the production process shall not exceed 3.5 grams per imperial gallon.
Section 3	requires specific information about all gasoline produced in Canada for use or sale after September 1974.

2.2.3 Leaded Gasoline Regulations, amendment, SOR/75-104

Section 1.1	the Leaded Gasoline Regulations do not refer to gasoline for use in aircraft.

2.2.4 Intent to Investigate the Phase-Down of Lead Content in Motor Gasoline

This document announces that an investigation is proposed on the merits of developing regulations to reduce the lead content in motor gasoline. The investigation will assess:

(i) effect of fuel regulations on automotive lead emissions
(ii) effect on the primary and secondary industry
(iii) effect on the manufacturers of lead additives
(iv) effect on the petroleum refining industry
(v) effect on petroleum marketing
(vi) effect on spare parts and auto maintenence industries
(vii) effect on automobile owner
(viii) effect on human health.

Briefs to be submitted by October 1980.

2.3 Secondary Lead Smelter Related Regulations

2.3.1 Secondary Lead Smelter National Emission Standards Regulations, SOR/76-464

Pursuant to Sections 6 and 7 of the Clean Air Act, SC 1971 c. 47.

Section 3	these regulations shall not permit a discharge via smelter exceeding quantities permitted under any law of any province.
Section 4	prescribes the permitted quantity of particulate matter emitted into the ambient air by secondary lead smelters.
Section 5, 6	prescribes the maximum permitted concentration of lead and particulate matter emitted into the ambient air by secondary lead smelters.
Section 8	provides relief from the preceding emission standards in the event of malfunction or breakdown.

Section 9	requires industry to submit emission test reports.

2.3.2 Secondary Lead Smelter National Emission Standards Regulations, amendment, SOR/77-1029

Section 1	requires that certain samples and related information requested by the Minister be provided by an operator using a prescribed method.

2.3.3 Secondary Lead Smelter National Emission Standards Regulations, amendment, SOR/80-126

This amendment replaces references in the regulations to the lead analytical method with a newly developed method for the measurement of emissions of particulate matter and lead from secondary lead smelters.

2.4 Metallurgical Industries Related Regulations

2.4.1 Metallurgical Industries Arsenic Information Regulations, SOR/77-265

Pursuant to Section 6 of the Clean Air Act, SA 1971, c. 47.

These regulations require operators to provide information relating to the operation of metallurgical works with respect to emission of arsenic.

2.4.2 Metallurgical Industries Mercury Information Regulations, SOR/77-266

Pursuant to Section 6 of the Clean Air Act, SA 1971, c. 47

These regulations require operators to provide information relating to the operation of metallurgical works with respect to emission of mercury.

2.5 Asbestos Mining and Milling National Emission Standards Regulations, SOR/77-514

Pursuant to Sections 6 and 7 of the Clean Air Act, SC 1971, c. 47

Section 3	these regulations do not permit the emission of asbestos fiber in quantities exceeding those permitted under law of any province.
Section 4	prescribes the maximum permitted number of asbestos fibers to be emitted in gases into the ambient air.
Section 5	in the case of malfunction or breakdown provides for more

	excessive emission of asbestos fibers.
Section 6	requires emission measurement reports.

2.6 Chlor-Alkali Mercury National Emission Standards Regulations, SOR/77-548

Pursuant to Sections 6 and 7 of the Clean Air Act, SC 1971, c. 47

Section 3	these regulations do not permit a plant to emit mercury in a quantity exceeding any law of any province.
Section 4	specifies maximum permitted amounts of mercury emitted into the ambient air by a plant.
Section 5	requires an operator of a plant to provide emission measurements where requested.

2.7 Fuels Information Regulations, SOR/77-597

Pursuant to Section 23(b)(iii) of the Clean Air Act, SC 1971, c. 47

These regulations require all producers or importers of fuel to submit information regarding the chemical composition of the fuels. An amendment in 1979 required information regarding atmospheric pollutants resulting from the combustion of fuel. However, in 1980, that amendment was revoked.

2.8 Vinyl Chloride National Emission Standards Regulations, SOR/79-299

Pursuant to Sections 6 and 7 of the Clean Air Act, SC 1971, c. 47

Section 3	these regulations do not permit a vinyl chloride plant or polyvinyl chloride plant to emit vinyl chloride in quantities exceeding that permitted by any province.
Section 4	stipulates permitted maximum vinyl chloride emissions into the ambient air.
Section 5	requires an operator of a vinyl chloride plant or polyvinyl chloride plant to submit information regarding incidents of exceeding emission standards.

2.9 Ambient Air Quality Objectives

2.9.1 Ambient Air Quality Objectives, SOR/74-325

Pursuant to Section 4(2) of the Clean Air Act, SC 1971, c. 47

These regulations specify ranges of desirable and acceptable emissions of sulphur dioxide, suspended particulate matter, carbon monoxide, and oxidants (ozone).

2.9.2 Ambient Air Quality Objectives, No. 2, SOR/75-32

These regulations specify desirable and acceptable ranges of emissions of nitrogen dioxide.

2.9.3 Ambient Air Quality Objectives, No. 3, SOR/78-74

These regulations identify a tolerable range of emissions of sulphur dioxide, suspended particulate matter, carbon monoxide, oxidants (ozone), and nitrogen dioxide. Measurement methods are also prescribed.

2.10 Emission Guidelines

The Minister of the Environment has published six sets of emission guidelines relating to the cement industry, asphalt paving industry, metallurgical coke manufacturing industry, arctic mining industry, packaged incinerator industry, and wood pulping industry. Termed "national emission guidelines," they specify which quantities of certain contaminants should not be emitted into the ambient air by the respective industries. The guidelines for the cement and asphalt paving industries concern particulate emissions. The guidelines for the metallurgical coke and arctic mining industries concern particulate matter as well as sulphur dioxide emissions. The guidelines for packaged incinerators concern particulate matter, hydrogen chloride, sulphur dioxide, and visible emissions. The guidelines for the wood pulping industry concern particulate matter, total reduced sulphur compounds, and sulphur dioxide.

The structure of the guidelines for the first four categories of industries are essentially parallel. All four sets of guidelines provide definitions of specific terms related to the industry, stipulate emission guidelines, provide exceptions for malfunctions, require emission testing, and require submission of specific records. The guidelines for the metallurgical coke and arctic mining industries also include a waiver of emission testing under certain circumstances. The guidelines for arctic mining include, in addition, a provision for a waiver of compliance as well as an additional schedule for recording sulphur dioxide emissions. The guidelines for the packaged incinerator industry and wood pulping industry are the most complex of the six sets. The packaged incinerator guidelines stipulate emission limits for new installations as well as emission limits for existing installations. In the latter case, an existing installation simply should not exhibit visible emissions exceeding 20 percent opacity. Schedule A pursuant to these guidelines classifies types of wastes. The guidelines for the wood pulping industry contain emission guidelines for new kraft pulping facilities, new sulphite pulping facilities, and steam-producing combustion units.

3. Related Provincial Legislation and Policies

3.1 Environment Council Act, RSA 1980, c. E-13

Section 1

"natural resources" means land, plant life, animal life, water, and air.

Section 2

"matters pertaining to the environment" consist of:

- (a) the conservation, management, and utilization of natural resources;
- (b) the prevention and control of pollution of natural resources;
- (c) the prevention of noise and the control of noise levels resulting from commercial or industrial operations in so far as they affect the environment in the vicinity of those operations;
- (d) economic factors that directly or indirectly affect the ability of persons to carry out measures that relate to the matters referred to in classes (a), (b), and (c);
- (e) any operations or activities
  - (i) that adversely affect or are likely to adversely affect the quality or quantity of any natural resource, or
  - (ii) that destroy, disturb, pollute, or alter or make use of a natural resource or are likely to do so;
  - (f) the preservation of natural resources for their aesthetic value;
  - (g) laws in force in Alberta that relate to or directly or indirectly affect the ecology of the environment or natural resources.

Section 4(1)

enables the Lieutenant Governor in Council to constitute panels to hold public hearings on matters pertaining to environment conservation or whenever an appeal of a stop order is referred to the Council.

Section 7(1)

The Council

- (a) shall conduct a continuing review of policies and programs of the Government and government agencies on matters pertaining to environment conservation and shall report on them to the Minister;
- (b) shall, on being requested to do so by the Minister, investigate any matter pertaining to environment conservation specified in the request and make its report on the matter to the Minister;
- (c) may require any officers or employees of any department of the Government or any government agency to provide information that, in the opinion of the Council, is necessary for the purposes of enabling it to carry out its

responsibilities;

(d) shall, on being requested to do so by an order of the Lieutenant Governor in Council, hold public hearings for the purpose of receiving briefs and submissions on the matter pertaining to environment conservation specified in the order, and shall make its report on the matter to the Lieutenant Governor in Council and the Minister;

(e) may from time to time as it considers necessary, but at least once a year, hold joint meetings with the public advisory committees;

(f) may refer any matter pertaining to environment conservation to the Department of the Environment for its recommendations and report on it;

(g) may engage the services of persons having special technical or other knowledge in connection with an inquiry of any matter pertaining to environment conservation that the Council, with the approval of the Minister, has undertaken or proposed to undertake;

(h) through the medium of the Department of the Environment, shall use its best efforts to achieve co-ordination of policies, programs, and administrative procedures of the Government and the government agencies relating to matters pertaining to environment.

3.2 Department of the Environment Act, RSA 1980, c. D-19 and amendments to January 1, 1985

Section 1	"natural resources" means land, plant life, animal life, water, and air.
Section 2	"Matters pertaining to the environment" are defined identically to the definition in the Environment Council Act.
Section 11	establishes the Natural Resources Co-ordinating Council to review policies, programs, service, and administrative procedures of any department or agency in matters pertaining to the environment.
Section 12	establishes the Conservation and Utilization Committee.

3.3 Land Surface Conservation and Reclamation Act, RSA 1980, c. L-3 and amendments to January 1, 1985

Section 1	by definition "natural resources" means land, plant life, animal life, water, and air.

Section 3	the Crown is bound by the Act.
Section 5	the Minister shall promote and co-ordinate the preparation and maintenance of an inventory of natural resources, and the recording, analysis, compilation, and dissemination of statistical data and information required for administration of the Act.
Section 8(1)	for any surface disturbance the Minister may require an Environmental Impact Assessment (EIA) report.
Section 8(2)	an order for an EIA may require assessment of: (a) conservation, management, and utilization of natural resources; (b) the prevention and control of pollution of natural resources; (c) the prevention and control of noise as they affect the environment in the vicinity of an operation or activity; (d) economic factors affecting (a) (b) (c); (e) preservation of natural resources of aesthetic value.
Section 9	the Minister may issue a "stop order" if the Act is contravened or the degree of surface disturbance or other damage or consequences is greater than what was foreseen at the time of approval.

3.4 Land Conservation Regulations, AR 125/74 and amendments to January 1, 1985

Pursuant to Sections 11, 13, 23, and 25 of the Land Surface Conservation and Reclamation Act, RSA 1980, c. L-3

Section 15-18	establish the Crown Mineral Disposition Review Committee.
Section 19-20	establish the Exploration Review Committee.
Section 21-23	establish the Development and Reclamation Review Committee.

3.5 Oil and Gas Conservation Act, RSA 1980, c. O-5 and amendments to January 1, 1985

Section 1	(c) "Board" means the Energy Resources Conservation Board.

Section 3	the Act applies to every well in Alberta, and any product from them.
Section 4	a purpose of the Act is to: (f) control pollution above, at, or below the surface in the drilling of wells and in operations for producing oil, gas, and other operations within the Board's jurisdiction.
Section 10(1)	the Board may make many types of regulations including: (j.1) as to the location of wells and the methods of operation to be observed during drilling . . . (for) (i) the protection of life, property and wildlife (ii) the prevention and extinguishment of fires, (iii) the prevention of wells blowing out of control. (n) requiring and prescribing any tests, analyses, surveys, and logs.
Section 10(2)	the Board, with approval of the Minister of the Environment, may make regulations: (a) restricting drilling and producing operations in water-covered areas, (b) as to the management and conduct of any well for the prevention of pollution, (c) prescribing measures to be taken to control pollution above, at, or below the surface in the drilling of wells and in operations for the production of oil and gas.
Section 30	requires an "industrial development permit" to be issued for the use, as raw materials or fuel in any industrial or manufacturing operation, of any energy resources produced in Alberta.
Section 33	The Board may suspend operations or shut down a well or battery.
Section 88	Board members or persons authorized by the Board shall have access to all wells, equipment, plant, and records; and are entitled to inspect all premises, books, and equipment; and to take samples or carry out any tests. Non-compliance is an offence.
Section 97	contravention of any provision of the Act, regulations, or any order or direction of the Board made under the Act is an offence.
Section 99	penalties for corporations committing offences under this Act may result in fines of between $300 and $1,000, and if

continued, of between $100 and $500 per day subsequent to the first day.

penalties for individuals are less.

3.6 Oil and Gas Conservation Regulations, Alta. Reg. 151/71 with amendments to January 1, 1985

Pursuant to the Oil and Gas Conservation Act, RSA 1980, c. O-5

Section 2.110	no well shall be drilled within 100 metres of any surface improvements, except under special conditions.
Section 7.040(1)	prohibits burning of oil, gas, oily waste, or other material produced or used at a well or in the operation of a scheme, except under conditions of controlled combustion where there is no significant or visible emission of smoke, unless there is written permission from the Board to do so.
Section 7.040(2)	burning of well or plant effluent is permitted in emergencies due to equipment failure, but must be immediately reported to the Board.
Section 7.050	this section dealing with master and check valves, casing, tubing, and vents shall apply where hydrogen sulphide concentration from a well exceeds 50 moles per kilomole (or higher or lower ratio specified by the Board), having regard to pressures, nature of production, remoteness of the area, and other circumstances.
Section 7.060	this section dealing with flaring shall apply to all wells that produce gas containing more than 10 moles per kilomole hydrogen sulphide, with the same exceptions as Section 7.050.
Section 7.070	this section deals with batteries at which the hydrogen sulphide concentration of the gas emitted exceeds 10 moles per kilomole. (5) the operator must erect signs at the entrance to the battery warning of the presence of poisonous gas. (8) gas must be disposed of at a well or battery so that the average concentration of hydrogen sulphide and sulphur dioxide in the ambient air does not exceed the maximum permissible concentrations set out in the Clean Air (Maximum Levels) Regulation or any other standards of the Board or the Department of the Environment. (10) the Board may exempt a battery from the provisions of this section if the Board decides that the nature of the production, remoteness of the area, or other

	circumstances warrant it.
Section 8.150(7)	if the Board is satisfied that waste disposal methods will not pollute air, soil, or potable water sources, it may approve disposal methods other than those prescribed in this section.
Section 9.030	prohibits starting construction related to a new scheme for processing gas unless approved by the Board and the Minister of the Environment regarding the location, conservation levels, and pollution control features.
Section 9.040	operators of processing plants shall operate such that they maintain the average maximum concentration of any air contaminant in the ambient air within the maximum permissible concentrations.
Section 9.050	details regarding air and water emissions from processing plants.
Section 9.070	the Board can suspend operations at a gas plant or require remedial measures.
Section 11.010 to 11.160	specify well data required, including drilling cuttings, oil sands data, core and core analysis, tests, surveys, and logs.
Section 12.010 to 12.160	specify records and reports required.
Section 15.010 to 15.240	specify information which must be provided on certain applications including detailed discussions of proposed methods to control emissions to air and water.

3.7 Oil Sands Conservation Act, RSA 1980, c. O-55

Section 3	a purpose of the Act is to: e) help control pollution from oil sands development and production.
Section 5-9	outline powers of the ERCB including conducting investigations and issuing stop orders.
Section 10,11	require ERCB approval of oil sands schemes, operations, and processing plants.

Section 12	requires applications for oil sands developments to be referred to the Minister of the Environment and Associate Minister of Public Lands and Wildlife for their approval with or without conditions.
Section 21	specifies the types of regulations that the ERCB can make respecting oil sands development.

3.8 Hydro and Electric Energy Regulation, A.R. 409/83 and amendments to January 1, 1985

Pursuant to Section 3 of the Hydro and Electric Energy Act, RSA 1980, c. H-13

Section 6	requires all holders of an approval to operate a thermal power plant to submit to the Board (a) a monthly air emission report summary sheet for each stack within 30 days of the end of the preceding month. (b) an annual air emission report for each stack by March 1 of the succeeding year, and (c) a copy of manual stack survey reports within 30 days after the survey was made.
Section 7	power plant operators shall notify the Board (a) if the power plant fails to perform in accordance with the specifications of the application or conditions of the approval (b) of any steps proposed to correct the performance of the power plant.

3.9 ERCB Interim Directives, Information Letters, Guidelines, and Reports

ID-OG 76-2 Emergency Procedure Plans for Sour Gas Facilities

sets out the minimum requirements for the content of a contingency plan in the event of an uncontrolled release of contaminants to air, water, or land.

ID 81-3 Minimum Distance Requirements Separating New Sour Gas Facilities from Residential and Other Developments

separation distances developed jointly by Alberta Environment and the Board.

the distances increase as the potential sour gas release volumes increase and with increasing population density.

the Subdivision Regulations of the Planning Act, 1977 were amended by OC 28/3/79 to require setbacks similar to the Board's separation distances to prevent encroachment of occupied buildings on existing sour gas facilities.

ID 81-4 Proposed Wells and Pipelines Near Urban Centers

to ensure that municipalities are aware of wells and pipelines proposed near cities, towns, or villages, applicants are required to advise municipal administrations.

IL-OG 72-20 Environmental Monitoring Program

establishes the Board as the "single window" for co-ordinating approvals, permits, and licences for gas processing operations.

inspection and surveillance of energy resource recovery, control features are normally a Board responsibility.

off-site inspection and monitoring is the Department's responsibility.

IL-OG 76-17 Incinerator Stack Surveys

specifies the information from stack surveys at sour gas plants that is to be submitted to the ERCB.

IL 79-16 Revised Incinerator Stack Exit Temperature Criteria for Plants Processing Sour Gas

considers the trial period for determining occurrence of reportable low temperatures as provided in IL-OG 76-24 to have been successful.

therefore operators will not have to report low stack exit temperatures which deviate from those specified in the Alberta Environment Licence and the Board Approval by less than 15° C for less than 15 minutes.

IL 79-22 Revised Environmental Monitoring Requirements for Plants Processing Sour Gas

jointly developed (Alberta Environment and ERCB) new criteria for revising several environmental monitoring requirements based on recommendations of a joint government/ industry committee.

new criteria will affect environmental monitoring using:

(1) static exposure stations for total sulphation and H_2S
(2) continuous ambient air monitoring and reporting
(3) sulphur dustfall monitoring

(4) incinerator stack surveys.

IL 80-24 Sulphur Recovery Guidelines — Gas Processing Operations

jointly issued (Alberta Environment and ERCB) guidelines.

result of federal/ provincial/ industry investigations.

expects that some variance may be appropriate where, for example, due to certain constraints, reductions in the recovery efficiency requirements appear to be environmentally acceptable.

specifies expected maximum sulphur recovery for new plants with inlet rates exceeding 10 tons per day of sulphur.

gas processing scheme approvals will stipulate a required quarterly average recovery 0.3 percent less than value calculated above to allow for start-up, shut-down, and other abnormal operating periods.

IL 80-30 Application for Approval of Natural Gas Compressors

specifies exhaust emission requirements for new or expanded gas compression facilities.

will be reviewed when additional information on oxide of nitrogen (NO_x) emissions is available.

Guide-23 Guidelines Respecting an Application for a Commercial Crude Bitumen Recovery and Upgrading Project (1981)

joint Alberta Environment/ ERCB report.

all applications to the ERCB for commercial crude bitumen recovery and upgrading projects must include an EIA.

an EIA shall include a Biophysical Impact Assessment which requires that air be assessed to provide information on:

(a) base-line conditions
(b) expected impacts of project
(d) significance of each impact
(c) measures to mitigate or enhance impacts
(e) unavoidable adverse impacts.

Guide-25 Industrial Development Permit Applications to the ERCB — A Guide to Content (1981)

joint Alberta Environment/ ERCB report.

all applications must consider air quality, including:

(a) existing ambient air quality, noting other licensed industrial emissions in area and general meteorological conditions
(b) type, volume, source of air emissions (including fugitive sources)
(c) frequency of ice-fog
(d) cooling system alternative regarding effects on agricultural land, visual impact, and noise.

Guide-26 Sour Gas Processing Plant Applications to the ERCB — A Guide to Content (1981)

joint Alberta Environment/ ERCB report.

all sour gas processing plant applications must provide information on air quality, including:

(a) existing ambient air quality
(b) type, volume, and source of air emissions (including fugitive sources)
(c) sulphur recovery level and maximum average daily emission of sulphur dioxide, and sulphur handling and storage facilities
(d) results of plume-dispersion calculations, illustrating volume and extent of maximum ground-level concentrations of sulphur dioxide and nitrogen dioxide.

Guide-28 Thermal Power Plant Applications to the ERCB — A Guide to Content

joint Alberta Environment/ ERCB report.

Biophysical Impact Assessment shall provide information on air quality, including:

(a) existing conditions
(b) nature and significance of impact on existing biophysical environment during construction and operation
(c) measures to alleviate impacts
(d) irreversible, adverse impacts
(e) mitigative measures.

Energy Resources Conservation Board. 1982. *Sour Gas Processing In Alberta*. Report 82-D. A Review of Evidence Presented at Recent ERCB Hearings Respecting the Impacts and Surveillance of Sour Gas Plants. Various pagination.

a special report to the Lieutenant Governor in Council on broad environmental issues relating to sour gas operations in general.

Board's assessment of the arguments, conclusions, and recommendations regarding:

acidification of soils

SO_2 emissions regarding livestock diseases

impact of SO_2 emissions on streams and lakes

emission of trace metals and other chemicals

sulphur recovery

recommendation 21 of the Acid Rain Subcommittee

injection of waste gases

adequacy of current monitoring equipment

accuracy of plant emission records and surveillance of plants for compliance with requirements.

3.10 Planning Act, RSA 1980, c. P-9 and amendments to January 1, 1985

Section 2	the purpose of Act is to enable preparation of plans to: (a) achieve orderly, economical, and beneficial development and use of land and patterns of human settlement, and (b) maintain and improve the quality of the physical environment without infringing on the rights of individuals except to the extent necessary for the greater public interest.

3.11 Subdivision Regulation, AR 132/78 and amendments to January 1, 1985

Pursuant to Section 145, the Planning Act, RSA 1980, c. P-9

Section 6(1)(j)	if a proposed subdivision is within 1.5 km of a sour gas facility, the application must be referred to the ERCB.
Section 11.1	specifies subdivision approval requirements with respect to sour gas facilities.

3.12 Rural Industrial Land Use Policy

Section 2.1	human activities should be in harmony with the environment in which they are situated.
Section 3.2	Regional Plans and other planning instruments must recognize

the economic, environmental, and other imperatives associated with the accommodation of an increasingly diversified range of industrial developments.

Section 3.2.4

Industries with emissions that are offensive or hazardous to human health, safety, and well-being should be classified as noxious and would include:

petro-chemical industries

petroleum refineries

rendering plants

alfalfa processing plants

secondary metals industries.

APPENDIX B

TRENDS IN ALBERTA'S AMBIENT AIR QUALITY, 1973-1981

INFORMATION SOURCES

OXIDES OF NITROGEN
- Edmonton and Calgary
- Other Communities

OZONE
- Edmonton and Calgary
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SULPHUR DIOXIDE
- Edmonton and Calgary
- Other Communities

HYDROGEN SULPHIDE
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- Edmonton and Calgary
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CARBON MONOXIDE
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HYDROCARBONS
- Edmonton and Calgary
- Other Communities

SUSPENDED PARTICULATES
- High-Volume Samplers
  - Edmonton and Calgary
  - Other Communities

- Soiling Index
  - Edmonton and Calgary
  - Other Communities

- Dustfall Rate
  - Edmonton and Calgary
  - Other Communities

FLUORIDES

INFORMATION SOURCES

The ambient air quality data reviewed in this appendix is primarily based on the Air Monitoring Reports published annually by Alberta Environment. These reports summarize the ambient air quality data collected in Edmonton and Calgary, compare the data with the ambient air quality standards to determine the level of compliance, and also provide source emission inventories to indicate contributions of the major sources (i.e. industry, motor vehicles). Published reports from 1973 through to 1979, as well as draft material from 1980 and 1981 reports, were used.

Additional unpublished data, particularly for communities other than Edmonton and Calgary, were obtained directly from the Air Quality Control Branch, Pollution Control Division, Alberta Environment in the form of tables and computer printouts. The assistance of W.S. Macdonald, Engineer, is greatly appreciated.

OXIDES OF NITROGEN

Nitric oxide (NO) and nitrogen dioxide (NO_2) are produced during combustion processes. At high combustion temperatures, NO formation is favored. During further reactions in the atmosphere, some of this NO is converted to NO_2. Of the two, nitrogen dioxide has the greater potential for causing adverse health and environmental effects.

Approximately half of the nitrogen oxide emissions in Alberta come from industrial sources such as natural gas processing and thermal power generation (Legge *et al.* 1980). Automobiles are another major source of these emissions.

Edmonton and Calgary

The total emissions of nitrogen oxides for Edmonton and Calgary during 1973 were 18.16×10^6 kg and 13.22×10^6 kg respectively (Alberta Environment 1978a, 1978b). The greater emissions in Edmonton can be attributed to the presence of thermal power plants in this city. Half (49.7 percent) of Edmonton's NO_x emissions were from automobiles and in Calgary, automobiles contributed almost two-thirds (64.6 percent).

Nitrogen oxides are monitored continuously at the six main urban stations in Edmonton and in Calgary. The annual means for the Edmonton stations are given in Table B-1. Since 1975, they have ranged from 0.02 to 0.11 ppm. The industrial station has consistently exhibited much lower concentrations than the other two stations. None of the stations have exhibited an increase in NO_x concentrations between 1975 and 1981. In fact, a slight reduction in NO_x concentrations at the residential station is evident.

In Calgary, the residential station has maintained the lowest NO_x concentrations of the three stations (Table B-1). There has been no significant change in the annual mean NO_x concentrations between 1975 and 1981.

TABLE B-1. Ambient Oxides of Nitrogen - Edmonton and Calgary

Station	Annual Mean Concentrations						
	1975-76	1976-77	1977-78	1978-79 (ppm)	1979-80	1980-81	1981[1]
Edmonton							
Downtown	0.11	0.11	0.09	0.09	0.09	0.09	0.09
Industrial	0.04	0.02	0.03	0.04	0.04	0.04	0.04
Residential	0.10	0.11	0.10	0.10	0.08	0.06	0.07
Calgary							
Downtown	0.08	0.08	0.08	0.09	0.09	0.08	0.08
Industrial	0.08	0.08	0.09	0.07	0.08	0.07	0.06
Residential	n.d.[2]	0.03	0.04	0.04	0.04	0.03	0.03

[1] March - December
[2] n.d. = no data

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

In addition to the total oxides of nitrogen, nitrogen dioxide (NO_2) is measured at these stations. In Edmonton, the annual mean concentrations of NO_2 have ranged from 0.01 to 0.06 ppm (Table B-2). The downtown station consistently registered the highest annual mean of the three stations. It decreased from 0.06 ppm in 1975 to 0.04 ppm in 1977 and has since remained at this level. In Calgary, the annual mean NO_2 concentrations have ranged from 0.02 ppm to 0.05 ppm (Table B-3). Except for 1975, the downtown station has always registered the highest annual concentration. The mean annual concentration at this station has remained at approximately 0.04 ppm over the past five years.

Since 1975 in Edmonton and 1976 in Calgary, the annual mean concentration of NO_2 at their downtown stations has consistently exceeded the maximum permissible concentration under Alberta's Clean Air (Maximum Levels) Regulation (Tables B-2 and B-3). This concentration (0.03 ppm) corresponds to the maximum desirable limit as determined by the Federal-Provincial Committee on Air Pollution (Fisheries and Environment Canada 1976). Exceeding this limit, however, does not necessarily mean that a danger to health or to the environment exists. Indeed, the aforementioned committee suggests that 0.05 ppm is the maximum acceptable level below which adequate protection for all parts of the environment is provided (Fisheries and Environment Canada 1976: 27). Since 1976, this concentration has not been exceeded in either city.

The Clean Air (Maximum Levels) Regulation also establishes the maximum permissible NO_2 concentrations for one-hour and 24-hour periods. They are 0.21 ppm and 0.11 ppm, respectively. These concentrations are occasionally exceeded in both cities (Tables B-2 and B-3); Calgary generally registers more contraventions than Edmonton.

Community health studies in the United States have shown a significant correlation between increased respiratory disease at mean 24-hour concentrations of between 0.06 and 0.11 ppm (U.S. Department of Health, Education and Welfare 1971). Concentrations within this range occur occasionally in both cities. This has led Alberta Environment to conclude that levels of nitrogen dioxide in Edmonton and Calgary may affect individuals suffering from respiratory ailments such as asthma (Alberta Environment n.d.b, n.d.c).

TABLE B-2. Ambient Nitrogen Dioxide - Edmonton

		Annual Mean (ppm)	Max. Reading (ppm)		Percentage of Readings Exceeding Regulation[1]		
Year	**Station**		**1-h**	**24-h**	**1-h**	**24-h**	**Annual**
1975-76	Downtown	0.06	0.25	0.11	< 1	< 1	100
	Industrial	0.01	0.13	0.07	0	0	0
	Residential	0.03	0.11	0.04	0	0	0
1976-77	Downtown	0.05	0.22	0.12	< 1	< 1	100
	Industrial	0.01	0.12	0.04	0	0	0
	Residential	0.02	0.12	0.06	0	0	0
1977-78	Downtown	0.04	0.18	0.08	0	0	100
	Industrial	0.02	0.08	0.05	0	0	0
	Residential	0.02	0.12	0.06	0	0	0
1978-79	Downtown	0.04	0.17	0.09	0	0	100
	Industrial	0.02	0.12	0.06	0	0	0
	Residential	0.03	0.12	0.09	0	0	0
1979-80	Downtown	0.04	0.19	0.12	0	< 1	100
	Industrial	0.02	0.13	0.05	0	0	0
	Residential	0.03	0.15	0.07	0	0	0
1980-81	Downtown	0.04	0.23	0.10	< 1	0	100
	Industrial	0.02	0.21	0.09	0	0	0
	Residential	0.02	0.20	0.06	0	0	0
1981[2]	Downtown	0.04	0.18	0.08	0	0	100
	Industrial	0.02	0.16	0.05	0	0	0
	Residential	0.03	0.14	0.07	0	0	0

[1] Clean Air (Maximum Levels) Regulation
1-h = 0.21 ppm; 24-h = 0.11 ppm; Annual = 0.03 ppm
[2] March - December

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

TABLE B-3. Ambient Nitrogen Dioxide - Calgary

		Annual Mean (ppm)	Max. Reading (ppm)		Percentage of Readings Exceeding Regulation[1]		
Year	**Station**		**1-h**	**24-h**	**1-h**	**24-h**	**Annual**
1975-76	Downtown	0.02	0.11	0.06	0	0	0
	Industrial	0.05	1.00	0.49	4	10	100
	Residential	0.04	0.38	0.25	< 1	< 1	100
1976-77	Downtown	0.04	0.35	0.12	< 1	< 1	100
	Industrial	0.03	0.39	0.13	< 1	0	0
	Residential	0.02	0.20	0.09	0	0	0
1977-78	Downtown	0.04	0.35	0.12	< 1	1	100
	Industrial	0.03	0.39	0.13	< 1	2	0
	Residential	0.02	0.20	0.09	0	0	0
1978-79	Downtown	0.04	0.24	0.14	< 1	< 1	100
	Industrial	0.03	0.19	0.11	0	0	0
	Residential	0.03	0.11	0.07	0	0	0
1979-80	Downtown	0.05	> 1.00	0.15	< 1	< 1	100
	Industrial	0.03	0.16	0.08	0	0	0
	Residential	0.02	0.12	0.07	0	0	0
1980-81	Downtown	0.04	0.22	0.09	< 1	0	100
	Industrial	0.02	0.13	0.07	0	0	0
	Residential	0.02	0.22	0.06	< 1	0	0
1981[2]	Downtown	0.04	0.16	0.08	0	0	100
	Industrial	0.02	0.13	0.06	0	0	0
	Residential	0.02	0.11	0.05	0	0	0

[1] Clean Air (Maximum Levels) Regulation
1-h = 0.21 ppm; 24-h = 0.11 ppm; Annual = 0.03 ppm

[2] March - December

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

Other Communities

Nitrogen oxides have been monitored for several years in Fort McMurray and on two occasions in each of Fort Saskatchewan, Medicine Hat, and Pincher Creek. Although the data are very limited, there is no indication that concentrations of NO_x and NO_2 have changed between visits (Table B-4). No contraventions of the Clean Air (Maximum Levels) Regulation were recorded.

OZONE

Oxidants are a group of oxidizing chemicals that can have adverse effects on human health, animals, plants, and materials such as rubber. In the atmosphere, oxidants include ozone (O_3), peroxy-nitrogen compounds, and nitrogen dioxide. Ozone is usually the most abundant oxidant and is of greatest concern with respect to health effects (Fisheries and Environment Canada 1976: 15).

Although ozone is produced naturally in the upper atmosphere, human activities contribute to additional ozone production. Ozone is not emitted directly into the atmosphere by industry or other activities. It is a secondary pollutant; ozone is formed from chemical reactions among other pollutants. The main source of this ozone formation is a photochemical reaction involving nitrogen dioxide, oxygen, and reactive hydrocarbons. In addition, light energy is required to initiate this process. As a general rule, ozone production increases as the NO_2:NO ratio increases (Legge *et al.* 1980: v). The main sources of NO_2, such as natural gas processing, thermal power plants, and transportation, are therefore important for their contribution to ozone formation as well.

TABLE B-4. Ambient Air Quality in Four Alberta Communities

	Mean Concentrations							
	NO_x (ppm)	NO_2 (ppm)	O_3 (ppm)	CO (ppm)	SO_2 (ppm)	H_2S (ppb)	THC (ppm)	S I (COH)
Fort Saskatchewan								
Nov. 15, 1976 - Apr. 30, 1977[2]	0.04	0.02	0.020	0.92	< 0.01	n.d.[1]	1.84	0.06
Nov. 1981 - Mar. 1982[3]	0.04	0.02	0.021	1.50	< 0.01	0.42	2.02	0.21
Medicine Hat								
Oct. 1 - 20, 1976[2]	0.05	0.02	0.013	1.51	< 0.01	n.d.	2.31	0.04
Nov. 1981[3]	0.05	0.02	0.012	1.82	< 0.01	n.d.	2.08	0.12
Pincher Creek								
Mar. 1 - May 30, 1980[2]	0.01	< 0.01	0.039	n.d.	< 0.01	< 10	1.9	n.d.
Jan. 1 - Mar. 24, 1981[2]	< 0.01	< 0.01	0.042	0.32	< 0.01	< 10	1.8	0.01
Fort McMurray								
Feb. - Dec. 1977[4]	0.02	0.01	0.020	0.60	< 0.01	n.d.	n.d.	n.d.
Jan. - Dec. 1978[4]	0.02	0.01	0.020	0.28	< 0.01	n.d.	n.d.	n.d.
Jan. - Dec. 1979[4]	0.02	< 0.01	0.017	0.44	< 0.01	n.d.	n.d.	n.d.

[1] n.d. = no data

[2] Air Monitoring Reports, Pollution Control Division, Alberta Environment

[3] Unpublished tables, Air Quality Control Branch, Pollution Control Division, Alberta Environment

[4] Adapted from Strosher 1981

Edmonton and Calgary

Ambient ozone concentrations are measured continuously at the six urban stations in Edmonton and Calgary. Data from these stations are available from 1974 on. In Edmonton, the annual mean concentration of ozone has ranged from 0.009 ppm to 0.026 ppm (Table B-5). Since 1976, the downtown station has exhibited the lowest ozone concentrations of the three Edmonton stations. In recent years, the industrial station has had the highest ozone readings. Any long-term trend in annual means has been masked by year-to-year variation. The mean annual ozone concentrations in Calgary have ranged from 0.011 ppm to 0.027 ppm since 1974 (Table B-6). The residential station at the University of Calgary has consistently had the highest annual mean and except for 1978, the downtown station has had the lowest. Apart from the high mean concentration at the industrial station in 1979, there appears to have been a slight decrease in the annual mean ozone concentration over the past eight years.

TABLE B-5. Ambient Ozone - Edmonton

		Annual Mean (ppm)	Max. Reading (ppm)		Percentage of Readings Exceeding Regulation[1]	
Year	**Station**		**1-h**	**24-h**	**1-h**	**24-h**
1974-75	Downtown	0.016	0.17	0.05	3[2]	43[2]
	Industrial	0.012	0.04	0.02		
	Residential	0.019	0.12	0.06		
1975-76	Downtown	0.025	0.10	0.07	14	75
	Industrial	0.016	0.08	0.04	< 1	45
	Residential	0.026	0.22	0.07	13	75
1976-77	Downtown	0.022	0.115	0.065	11	54
	Industrial	0.023	0.170	0.114	7	52
	Residential	0.025	0.140	0.090	14	65
1977-78	Downtown	0.014	0.090	0.037	< 1	36
	Industrial	0.015	0.070	0.043	< 1	44
	Residential	0.015	0.105	0.049	< 1	40
1978-79	Downtown	0.009	0.070	0.030	< 1	16
	Industrial	0.017	0.080	0.041	< 1	58
	Residential	0.017	0.105	0.048	< 1	50
1979-80	Downtown	0.012	0.065	0.041	< 1	31
	Industrial	0.023	0.090	0.065	4	71
	Residential	0.019	0.155	0.064	4	59
1980-81	Downtown	0.012	0.070	0.038	0	7
	Industrial	0.019	0.095	0.056	< 1	29
	Residential	0.015	0.075	0.046	0	15
1981[3]	Downtown	0.013	0.085	0.041	< 1	7
	Industrial	0.022	0.155	0.050	< 1	36
	Residential	0.020	0.135	0.054	< 1	28

[1] Clean Air (Maximum Levels) Regulation: before September 13, 1979;
1-h = 0.051 ppm; 24-h = 0.015 ppm; after September 13, 1979;
1-h = 0.080 ppm; 24-h = 0.025 ppm.

[2] Combined for all three stations

[3] March - December

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

TABLE B-6. Ambient Ozone - Calgary

		Annual Mean (ppm)	Max. Reading (ppm)		Percentage of Readings Exceeding Regulation[1]	
Year	**Station**		**1-h**	**24-h**	**1-h**	**24-h**
1974-75	Downtown	0.014	0.070	0.042	1[2]	54[2]
	Industrial	0.015	0.080	0.043		
	Residential	0.025	0.095	0.048		
1975-76	Downtown	0.016	0.080	0.048	< 1	46
	Industrial	0.019	0.105	0.071	3	69
	Residential	0.027	0.094	0.049	7	89
1976-77	Downtown	0.012	0.070	0.043	< 1	26
	Industrial	0.016	0.135	0.058	5	45
	Residential	0.026	0.098	0.059	9	78
1977-78	Downtown	0.012	0.062	0.036	< 1	30
	Industrial	0.013	0.123	0.076	3	29
	Residential	0.021	0.081	0.045	1	67
1978-79	Downtown	0.014	0.088	0.044	< 1	40
	Industrial	0.012	0.054	0.033	< 1	28
	Residential	0.022	0.100	0.080	2	70
1979-80	Downtown	0.013	0.090	0.041	< 1	38
	Industrial	0.018	0.092	0.055	5	55
	Residential	0.023	0.170	0.063	6	66
1980-81	Downtown	0.012	0.075	0.042	0	10
	Industrial	0.013	0.070	0.042	0	8
	Residential	0.020	0.090	0.047	< 1	32
1981[3]	Downtown	0.011	0.088	0.031	< 1	3
	Industrial	0.013	0.054	0.033	0	4
	Residential	0.021	0.090	0.044	< 1	32

[1] **Clean Air (Maximum Levels) Regulation: before September 13, 1979; 1-h = 0.051 ppm; 24-h = 0.015 ppm; after September 13, 1979; 1-h = 0.080 ppm; 24-h = 0.025 ppm.**

[2] **Combined for all three stations**

[3] **March - December**

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

The Clean Air (Maximum Levels) Regulation includes a standard for "oxidants as equivalent ozone." This includes all oxidants, such as ozone, peroxyacetyl nitrate (PAN), and others. The monitoring program in Alberta, however, only measures ozone. While ozone probably is the most prevalent oxidant, comparing ozone concentrations with the oxidant standard invariably underestimates the actual contraventions of that regulation to a small degree.

Prior to 1980, the provincial standards corresponded to the maximum desirable concentrations as determined by the Federal-Provincial Committee on Air Pollution (FPCAP). From 1974 to 1979, all six stations reported readings above the maximum permissible ozone concentrations for both 1-hour and 24-hour periods. The percentage of readings exceeding the 24-hour regulation were especially high in Calgary. In 1975, 89 percent of the 24-hour averages at the residential station were above the provincial regulation.

On September 13, 1979, the maximum permissible oxidant concentrations were raised substantially because the high natural background levels in Calgary and Edmonton made compliance very difficult. The new standards are equivalent to the maximum *acceptable* concentrations of the FPCAP. As such, concentrations that exceed the new regulation should elicit control action by a regulatory agency (Fisheries and Environment Canada 1976: 1). It can be seen from Tables B-5 and B-6 that a substantial percentage of the 24-hour readings still exceed the higher regulation. Although Alberta does not have a regulation for the *annual* mean oxidant concentrations, the maximum acceptable annual mean according to the FPCAP is 0.015 ppm. This concentration has been equalled or exceeded in every year since 1975 at the Edmonton industrial and residential stations and since 1974 at the Calgary residential station. Alberta Environment states in recent air monitoring reports that ozone levels in Edmonton and Calgary can affect sensitive vegetation and materials and individuals predisposed to chronic pulmonary disorders (Alberta Environment 1980b, 1980c).

Other Communities

Ozone concentrations for Fort Saskatchewan, Medicine Hat, Pincher Creek, and Fort McMurray are presented in Table B-4. There is no indication that ozone levels have changed between visits. As in Edmonton and Calgary, contraventions of the provincial regulation were common, especially during the spring months when more light was available for photochemical ozone production. For example, in April of 1977, 97 percent of the 24-hour readings in Fort Saskatchewan exceeded the provincial regulation. In March of 1982, 82 percent of the ozone concentrations exceeded this regulation in Medicine Hat. Even during the winter months, almost all of the 24-hour readings for the Pincher Creek area were above the regulation (for example, 99.7 percent for February of 1981).

It appears that the maximum permissible concentration for ozone over a 24-hour period is regularly contravened in many regions of Alberta. High natural background levels of ozone play a major role in causing these excesses. Raising the maximum permissible concentration further could reduce this influence of natural ozone production. However, the concentrations at which adverse health and environmental effects occur cannot be legislated upwards. More information on background levels is needed. It may, in fact, be that people with pulmonary disorders and sensitive plants and materials will be affected by ozone in the air regardless of efforts to control the human contribution to ozone formation.

SULPHUR DIOXIDE

Sulphur dioxide (SO_2) has received a lot of attention during the past several years because of its role in the production of acid precipitation (Sanderson 1984). Most of Alberta's SO_2 emissions are derived from industrial sources. In 1981, oil and gas extraction and production contributed 79.3 percent of our industrial SO_2 emissions (Alberta Environment 1982b). Power plants, pulp and paper mills, and fertilizer plants produce most of the remaining industrial emissions.

Edmonton and Calgary

In the cities of Edmonton and Calgary, industrial sources produced 96 percent and 92 percent, respectively, of SO_2 emissions in 1973 (Alberta Environment 1978a, 1978b). The rest of the SO_2 emissions were derived from transportation sources.

Sulphur dioxide is monitored continuously at the six main urban stations in these two cities. Since 1973, concentrations have remained very low. Annual mean concentrations have never exceeded 0.01 ppm at any station. The maximum permissible concentration for a 1-hour period has been exceeded only five times in Edmonton since 1973. No other contraventions have occurred in either city.

Other Communities

Sulphur dioxide concentrations in Fort Saskatchewan, Medicine Hat, Pincher Creek, and Fort McMurray are also very low (Table B-4). No contraventions of the provincial regulation were recorded.

HYDROGEN SULPHIDE

Hydrogen sulphide (H_2S) is commonly associated with Alberta's natural gas and oil deposits. The extraction and processing of this "sour" gas and oil is a major source of H_2S in the ambient air. Marshes and bogs also release significant amounts of H_2S to the atmosphere. The characteristic rotten-egg odor of H_2S is detectable by some people at 0.01 ppm (J.C. Lack 1984: pers. comm.). Irritation to eyes and lungs can occur at 20 ppm and exposure to high concentrations (500-700 ppm) can be fatal (Greenhill 1978: 11).

Edmonton and Calgary

Thirty-day exposure cylinders have been used to monitor H_2S at the three stations in Edmonton. Annual means for 1975 to 1981 are presented in Table B-7. Hydrogen sulphide levels vary considerably from year to year with no readily apparent long-term trend. High levels of H_2S were recorded at the residential station in 1981. A peak reading of 0.125 as mg SO_3/ 100 cm^2/ d in December of that year is the only contravention of the provincial guideline (0.10 as mg SO_3/ 100 cm^2/ d) in Edmonton during the past seven years.

In Calgary, an 18-station network of exposure cylinders was operating until mid-1978. It was discontinued primarily because the observed readings were very low (W.S. Macdonald 1983: pers. comm.). While Edmonton's H_2S levels were lower than Calgary's in 1977, the presence of refineries in Edmonton justified the continuation of H_2S monitoring in that city (Ibid.). Annual means in Calgary from 1973 to 1977 are presented in Table B-7. There are insufficient data to draw conclusions about trends in Calgary's ambient H_2S levels.

TABLE B-7. Ambient Hydrogen Sulphide - Edmonton and Calgary

	Annual Mean								
	1974[1]	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981-82	1982[1]
	(as mg SO_3 / 100 cm^2/ d)								
Edmonton									
Downtown	n.d.[2]	n.d.	0.017	0.019	0.014	0.020	0.014	0.018	0.012
Industrial	n.d.	n.d.	0.013	0.021	0.020	0.023	0.015	0.020	0.021
Residential	n.d.	n.d.	0.013	0.021	0.019	0.017	0.015	0.031	0.015
Calgary (18 stations)	0.029	i.d.[3]	0.015	0.025	n.d.	n.d.	n.d.	n.d.	n.d.

[1] March - December
[2] n.d. = no data
[3] i.d. = insufficient data

Source: *Unpublished data, Air Quality Control Branch, Pollution Control Division, Alberta Environment*

Other Communities

Networks of H_2S exposure cylinders are maintained in 10 other communities in Alberta. Annual means from 1978 to 1982 are presented in Table B-8. There is substantial year-to-year variation and no general trends are evident. Contraventions of the provincial guideline for H_2S occurred in several of these communities. Some networks record high H_2S levels with some regularity. In Lethbridge, for example, Station 8 has exceeded the guideline seven times over the past five years. This station is located near the municipal sewage treatment plant and a large cattle feedlot which are probable sources of H_2S gas (W.S. Macdonald 1983: pers. comm.).

SULPHATION RATE

The sulphation rate (or total sulphation) is a measure of the total amount of sulphur-containing compounds in the air. These include SO_2, H_2S, SO_3, and others. Specially treated 30-day exposure cylinders or plates are used to monitor sulphation. There is no legislated regulation for sulphation rate, but there is a provincial guideline of 0.50 as mg SO_3/ 100 cm^2/ d (W.S. Macdonald 1983: pers. comm.).

TABLE B-8. Ambient Hydrogen Sulphide in Several Alberta Communities

Location	Mean Rate 1978-79	 1979-80	 1980-81	 1981-82	 1982[1]	 Average
	(as mg SO_3/100 cm^2/d)					
Camrose	0.015	0.014	0.011	0.009	0.021	0.014
Carseland	0.017	0.017	0.010	0.007	0.013	0.013
Coleman	0.034	0.049	0.022	0.021	0.027	0.031
Coleman (Willow Drive Herd)	0.012	0.022	0.012	0.023	0.014	0.017
Fort McMurray	0.017	0.017	0.012	0.014	0.022	0.016
Grande Prairie	n.d.[2]	0.017	0.010	0.003	0.016	0.012
Hinton	0.008	0.006	0.004	0.055	0.015	0.018
Lethbridge	0.025	0.027	0.013	0.020	0.047	0.026
Medicine Hat	0.017	0.015	0.008	0.018	0.012	0.014
Medicine Hat (Western Co-op Fertilizer)	0.015	0.017	0.005	0.025	0.013	0.015
Red Deer	0.016	0.018	0.008	0.011	0.027	0.016
Sherwood Park	0.019	0.021	0.012	0.016	0.014	0.016

[1] March - December

[2] n.d. = no data

Source: *Unpublished data, Air Quality Control Branch, Pollution Control Division, Alberta Environment*

Edmonton and Calgary

The Edmonton network of exposure cylinders consists of 29 stations. The annual mean sulphation rate has ranged from 0.07 to 0.17 as mg SO_3/100 cm^2/d between 1973 and 1981 (Table B-9). In Calgary, there are 38 exposure cylinders. The annual mean sulphation rate there has ranged from 0.12 to 0.24 as mg SO_3/100 cm^2/d (Table B-9). The sulphation rate in Calgary has consistently been higher than that of Edmonton. Although there are no obvious long-term trends, the sulphation rates in 1980 and 1981 were higher than in previous years, especially in Calgary.

TABLE B-9. Sulphation Rate - Edmonton and Calgary Networks

	Annual Mean Rate								
	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981[1]
	(as mg SO_3 / 100 cm^2/d)								
Edmonton	0.07	0.15	0.17	0.09	0.13	0.11	0.10	0.16	0.15
Calgary	n.d.[2]	0.16	i.d.[3]	0.12	0.16	0.16	0.15	0.24	0.21

[1] March - December
[2] n.d. = no data
[3] i.d. = insufficient data

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

Other Communities

Besides Edmonton and Calgary, the sulphation rate is monitored in 11 other communities. Their annual mean sulphation rates are presented in Table B-10. There are no consistent trends in most of these communities, although the rate recorded in Hinton has increased substantially over the past four years.

CARBON MONOXIDE

Nearly all of the carbon monoxide (CO) in urban air comes from anthropogenic sources. It is a colorless, odorless gas derived from combustion processes. Carbon monoxide has a high affinity for blood haemoglobin and can reduce the oxygen-carrying capacity in our blood. At high concentrations, CO can be fatal.

Edmonton and Calgary

Of all of the urban air pollutants, carbon monoxide is emitted in the greatest quantities. In 1973, CO contributed 82 percent and 73 percent of the total emissions in Edmonton and Calgary, respectively (Alberta Environment 1978a, 1978b). CO emissions in Edmonton were almost three times those in Calgary. The difference between the two figures is attributed to the CO produced in Edmonton refineries. CO emissions from these refineries have since been virtually eliminated with the installation of CO boilers in 1973. It is likely that CO emissions from automobiles now exceed those from industrial sources in Edmonton, as they do in Calgary.

TABLE B-10. Annual Mean Sulphation Rate in Several Alberta Communities

Location	1978-79	1979-80	1980-81	1981-82	1982[1]	Average
	Mean Rate (as mg SO_3/ 100 cm^2/ d)					
Camrose	0.068	0.067	0.070	0.058	0.077	0.068
Carseland	0.120	0.080	0.162	0.071	0.075	0.102
Coleman	0.221	0.194	0.235	0.155	0.167	0.194
Coleman (Willow Drive Herd)	0.068	0.077	0.143	0.103	0.079	0.094
Fort McMurray	0.073	0.060	0.085	0.076	0.069	0.073
Fort Saskatchewan	0.097	0.110	0.175	0.182	0.109	0.135
Fort Saskatchewan (Town)	0.100	0.084	0.101	0.188	0.095	0.114
Grande Prairie	n.d.[2]	0.040	0.045	0.029	0.095	0.052
Hinton	0.028	0.023	0.039	0.044	0.057	0.038
Lethbridge	0.174	0.136	0.173	0.140	0.149	0.154
Medicine Hat	0.086	0.089	0.084	0.078	0.070	0.081
Medicine Hat (Western Co-op Fertilizer)	0.067	0.056	0.050	0.041	0.073	0.057
Redwater	0.092	0.098	0.273	0.261	0.150	0.175
Sherwood Park	0.113	0.091	0.167	0.201	0.126	0.140

[1] March - December
[2] n.d. = no data

Source: *Unpublished data, Air Quality Control Branch, Pollution Control Division, Alberta Environment*

Carbon monoxide is monitored continuously at the six stations in Edmonton and Calgary. The annual mean CO concentration in Edmonton has ranged from 0.3 ppm to 3.3 ppm (Table B-11). Highest annual means have usually occurred at the downtown station. Readings at the industrial station are much lower than at the other two stations. No long-term trend is evident from the 1974-1981 data. However, higher CO levels were observed at the downtown station in 1979 and 1980.

In Calgary, annual CO concentrations appear to have decreased over the years. They have ranged from 1.0 to 3.1 ppm (Table B-12). Highest and lowest mean concentrations have occurred at the downtown and residential stations, respectively.

The Clean Air (Maximum Levels) Regulation specifies maximum CO concentrations for one-hour and eight-hour periods. Except at Edmonton's industrial station, these levels have been exceeded every year between 1974 and 1981. Because these regulations correspond to the maximum *desirable* concentration of the FPCAP, a contravention does not necessarily constitute a health hazard. However, the FPCAP's maximum *acceptable* concentrations are occasionally exceeded, especially at the Edmonton residential and Calgary downtown stations.

TABLE B-11. Ambient Carbon Monoxide - Edmonton

Year	Station	Annual Mean (ppm)	Max. Reading (ppm) 1-h	8-h	Percentage of Readings Exceeding Regulation[1] 1-h	8-h
	Downtown	1.9	18.0	5.33		
1974-75	Industrial	1.0	12.0	3.17	< 1[2]	2[2]
	Residential	1.7	17.0	5.81		
	Downtown	1.5	17.0	9.44	< 1	1
1975-76	Industrial	1.1	8.0	5.44	0	< 1
	Residential	1.9	14.5	8.75	< 1	3
	Downtown	1.6	16.5	8.31	< 1	< 1
1976-77	Industrial	0.6	6.0	4.00	0	0
	Residential	1.8	26.0	14.94	< 1	2
	Downtown	2.1	17.5	11.3	< 1	5
1977-78	Industrial	0.3	6.5	5.0	0	0
	Residential	1.5	28.0	13.2	< 1	3
	Downtown	2.2	20.0	9.6	< 1	7
1978-79	Industrial	0.4	6.0	2.1	0	0
	Residential	1.3	25.0	9.0	< 1	2
	Downtown	3.3	28.0	15.6	< 1	17
1979-80	Industrial	0.4	4.5	2.7	0	0
	Residential	1.9	30.0	14.6	< 1	6
	Downtown	2.8	21.7	14.6	< 1	8
1980-81	Industrial	0.8	9.4	4.7	0	0
	Residential	1.9	29.8	15.9	4	6
	Downtown	2.0	20.3	11.8	< 1	4
1981[3]	Industrial	1.0	8.3	4.6	0	0
	Residential	1.4	21.9	15.0	< 1	5

[1] Clean Air (Maximum Levels) Regulation 1-h = 13 ppm; 24-h = 5 ppm
[2] Combined for all three stations
[3] March - December

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

Other Communities

Carbon monoxide has been monitored on two occasions in each of Fort Saskatchewan and Medicine Hat and once in the Pincher Creek area (Table B-4). Monitoring of CO has been discontinued in Fort McMurray (J. Torneby 1984: pers. comm.). In Fort Saskatchewan, the mean CO concentration increased substantially between 1976-77 and 1981-82. In view of the magnitude of the year-to-year variation observed in nearby Edmonton, however, this may not be an actual long-term trend. Similarly, the small increase observed at Medicine Hat between 1976 and 1981 may not be significant.

TABLE B-12. Ambient Carbon Monoxide - Calgary

Year	Station	Annual Mean (ppm)	Max. Reading (ppm)		Percentage of Readings Exceeding Regulation[1]	
			1-h	8-h	1-h	8-h
1974-75	Downtown	3.1	35.5	17.63	< 1[2]	6[2]
	Industrial	2.3	18.5	10.25		
	Residential	1.6	19.0	8.10		
1975-76	Downtown	2.6	28.0	17.13	< 1	6
	Industrial	2.2	16.0	11.63	< 1	4
	Residential	2.1	25.0	9.88	< 1	6
1976-77	Downtown	2.2	27.0	17.81	< 1	6
	Industrial	1.8	18.0	9.94	< 1	3
	Residential	1.3	20.0	8.75	< 1	4
1977-78	Downtown	2.5	36.0	22.2	< 1	8
	Industrial	1.6	24.5	16.5	< 1	3
	Residential	1.4	20.0	13.3	< 1	2
1978-79	Downtown	2.7	26.0	15.2	< 1	8
	Industrial	1.5	13.5	6.9	< 1	2
	Residential	1.1	13.5	6.8	< 1	< 1
1979-80	Downtown	2.8	36.0	20.1	1	10
	Industrial	1.5	26.5	19.6	< 1	3
	Residential	1.2	20.5	15.4	< 1	2
1980-81	Downtown	2.3	29.0	19.0	< 1	6
	Industrial	1.4	22.5	14.6	< 1	3
	Residential	1.0	15.5	9.6	< 1	1
1981[3]	Downtown	2.2	34.6	13.6	< 1	6
	Industrial	1.9	20.5	11.0	< 1	4
	Residential	1.0	21.0	8.4	< 1	2

[1] Clean Air (Maximum Levels) Regulation 1-h = 13 ppm; 8-h = 5 ppm
[2] Combined for all three stations
[3] March - December

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

HYDROCARBONS

Hydrocarbons are produced by both natural and anthropogenic sources. The main industrial sources are hydrocarbon (for example, petroleum products) storage and incomplete combustion in vehicle engines. While there is no evidence that gaseous hydrocarbons are deleterious, they do contribute to photochemical smog and ozone production (Legge *et al.* 1980). It should be noted, however, that the main constituent of gaseous hydrocarbons, methane, does not participate in these reactions.

Edmonton and Calgary

The 1973 source and emission inventories revealed that industry was the largest contributor of hydrocarbon emissions in Edmonton, whereas automobiles were by far the greatest source of hydrocarbons in Calgary.

Total hydrocarbons are monitored continuously at the six main stations in Edmonton and Calgary. In Edmonton, the annual mean concentration of hydrocarbons ranged from 1.8 to more than 3.6 ppm between 1976 and 1981 (Table B-13). Hydrocarbon concentrations in Calgary were slightly lower, ranging from 1.2 to 2.9 ppm between 1975 and 1981 (Table B-13). In both cities, concentrations of total hydrocarbons have remained relatively stable over the past several years.

Other Communities

Total hydrocarbon concentrations for Fort Saskatchewan, Medicine Hat, and Pincher Creek are presented in Table B-4. Changes between visits appear to be minimal.

SUSPENDED PARTICULATES

Particulate matter consists of the wide variety of solid substances dispersed in the air. By definition, the largest particle size considered has a diameter of 0.50 mm. Particulates include soils, dusts, combustion products, and many other kinds of particles. Three different methods are employed to measure particulates: suspended particulates using a high-volume sampler, soiling index using a tape sampler, and dustfall rate using dustfall collectors.

High-Volume Samplers

Edmonton and Calgary

High-volume samplers presently operate at the six main monitoring stations in Edmonton and in Calgary. Additional samplers were operated until 1980. In Edmonton, the average annual geometric mean for total particulates has ranged from 56 to 91 $\mu g/m^3$ during the past 10 years (Table B-14). The annual means for recent years (1979-1981) are higher than for previous years. In Calgary, the average annual geometric means have ranged from 77 to 161 $\mu g/m^3$ (Table B-15). It appears as well that in Calgary the concentrations of total particulates have increased during the past few years.

TABLE B-13. Total Hydrocarbons - Edmonton and Calgary

Station				**Annual Mean Concentrations**			
	1975-76	**1976-77**	**1977-78**	**1978-79 (ppm)**	**1979-80**	**1980-81**	**1981[1]**
Edmonton							
Downtown	n.d.[2]	2.0	2.0	2.2	1.8	2.1	2.2
Industrial	n.d.	2.4	2.6	> 3.6	2.5	2.5	2.8
Residential	n.d.	2.4	2.1	2.4	2.6	2.5	2.4
Calgary							
Downtown	1.6	2.2	2.4	2.4	2.9	2.2	2.1
Industrial	1.2	2.0	2.0	2.1	2.0	2.2	2.3
Residential	n.d.	1.6	2.0	2.0	2.1	1.8	1.8

[1] March - December
[2] n.d. = no data

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

Regulations have been set for total particulates based primarily on interference with visibility and the nuisance that particulates present. Health effects at or below these levels are a minor concern. However, there is some evidence that a health hazard exists when high concentrations of suspended particulates occur concurrently with high SO_2 concentrations (Alberta Environment 1980b: 14).

In both Edmonton and Calgary, most stations have consistently exceeded the annual standard of 60 $\mu g/m^3$. All stations report some contraventions of the 24-hour standards. Fortunately, sulphur dioxide levels have remained low and no adverse health effects should be anticipated (Alberta Environment 1980b, 1980c).

Other Communities

High-volume samplers were operated in several other communities for a number of years. Annual mean concentrations are given in Table B-16. While there is considerable year-to-year variation, particulate concentrations have generally remained the same over the past several years.

Soiling Index

Edmonton and Calgary

Formerly, the soiling index was measured at eight stations in Edmonton. It is now monitored only at the three main stations. Since 1973, the annual mean for the station network has increased from 0.12 to 0.28 COH units (Table B-17). It appears that the soiling index is generally increasing in Edmonton.

TABLE B-14. Total Suspended Particulates - Edmonton

Annual Geometric Mean

(μg/m^3)

	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981[1]
Station 1	68	66	73	133	132	76	66	85	n.d.[2]	n.d.
Station 2	49	51	46	61	63	49	41	n.d.	n.d.	n.d.
Station 3 (Industrial)	52	58	65	64	59	60	66	77	72	82
Station 4 (Downtown)	n.d.	n.d.	66	68	89	93	83	102	104	118
Station 5 (Residential)	n.d.	n.d.	61	61	69	62	66	92	81	72
Average	56	58	62	77	82	68	64	89	86	91

Percentage of Readings Exceeding the Provincial Regulation[3]

	1972-73		1973-74		1974-75		1975-76		1976-77	
	Annual	24-h	Annual	24-h	Annual	24-h	Annual	24-h	Annual	24-h
Station 1	100	0	100	0	100	30	100	72	100	74
Station 2	0	17	0	19	0	16	100	22	100	23
Station 3 (Industrial)	0	0	0	0	100	27	100	26	0	25
Station 4 (Downtown)	n.d.	n.d.	n.d.	n.d.	100	31	100	27	100	43
Station 5 (Residential)	n.d.	n.d.	n.d.	n.d.	100	21	100	18	100	34

	1977-78		1978-79		1979-80		1980-81		1981[1]	
	Annual	24-h	Annual	24-h	Annual	24-h	Annual	24-h	Annual	24-h
Station 1	100	36	100	25	100	34	n.d.	n.d.	n.d.	n.d.
Station 2	0	17	0	2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Station 3 (Industrial)	100	27	100	35	100	39	100	28	100	22
Station 4 (Downtown)	100	60	100	46	100	59	100	61	100	53
Station 5 (Residential)	100	28	100	28	100	46	100	33	100	12

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[1] March - December

[2] n.d. = no data

[3] Clean Air (Maximum Levels) Regulation 24-h = 100 μg/m^3; Annual = 60 μg/m^3

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

TABLE B-15. Total Suspended Particulates - Calgary

Annual Geometric Mean

(µg/m³)

	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981[1]
Station 1 (Downtown)	148	122	125	109	79	98	130	200	160
Station 2	90	100	55	75	89	61	75	n.d.[2]	n.d.
Station 3 (Industrial)	54	51	87	94	91	103	143	183	154
Station 4 (Residential)	n.d.	39	42	46	53	49	61	99	72
Average	97	78	77	81	78	78	102	161	129

Percentage of Readings Exceeding the Provincial Regulation[3]

	1974-75		1975-76		1976-77		1977-78		1978-79	
	Annual	24-h	Annual	24-h	Annual	24-h	Annual	24-h	Annual	24-h
Station 1 (Downtown)	100	70	100	72	100	67	100	39	100	53
Station 2	100	13	0	15	100	40	100	49	100	19
Station 3 (Industrial)	0	50	100	41	100	43	100	42	100	59
Station 4 (Residential)	0	3	0	9	0	12	0	7	0	5

	1979-80		1980-81		1981[1]	
	Annual	24-h	Annual	24-h	Annual	24-h
Station 1 (Downtown)	100	70	100	77	100	77
Station 2	100	25	n.d.	n.d.	n.d.	n.d.
Station 3 (Industrial)	100	73	100	65	100	68
Station 4 (Residential)	100	19	100	52	100	20

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[1] March - December

[2] n.d. = no data

[3] Clean Air (Maximum Levels) Regulation 24-h = 100 µg/m³; Annual = 60 µg/m³

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

TABLE B-16. Suspended Particulates (High-Volume Sampler) in Several Alberta Communities

Location	Mean Concentration ($\mu g/m^3$)											
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Average
Camrose	84	57	60	68	70	69	83	65	67	63	82	70
Fort McMurray	n.d.[1]	n.d.	n.d.	n.d.	92	51	120	72	44	44	59	69
Grande Prairie	n.d.	n.d.	n.d.	n.d.	i.d.[2]	65	97	109	88	148	87	99
Hinton	i.d.	158	100	i.d.	177	154	132	181	192	i.d.	n.d.	156
Lethbridge	n.d.	n.d.	n.d.	n.d.	57	44	48	58	55	69	72	58
Medicine Hat	76	68	67	88	101	87	89	79	78	67	n.d.	80
Red Deer	86	74	64	72	77	71	77	84	66	n.d.	n.d.	75
St. Albert	128	100	105	99	129	137	97	98	91	n.d.	131	112

[1] n.d. = no data
[2] i.d. = insufficient data

Source: *Unpublished data, Air Quality Control Branch, Pollution Control Division, Alberta Environment*

TABLE B-17. Soiling Index - Edmonton

	Annual Means (coefficient of haze (COH) units)								
	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981[1]
Station 1	0.04	0.09	0.14	0.16	0.15	0.17	0.16	n.d.[2]	n.d.
Station 2	0.10	0.04	0.17	0.20	0.19	0.20	0.27	0.32	0.37
Station 3	0.16	0.17	0.22	0.17	0.16	0.18	0.18	n.d.	n.d.
Station 4	0.12	0.14	0.17	i.d.[3]	0.11	0.13	n.d.	n.d.	n.d.
Station 5	0.17	0.22	0.22	0.21	0.21	0.24	0.22	n.d.	n.d.
Station 6	0.14	0.21	0.14	0.15	0.15	0.13	0.11	n.d.	n.d.
Station 7	n.d.	0.15	0.08	0.04	0.10	0.17	0.25	0.29	0.26
Station 8	n.d.	0.12	0.12	0.11	0.09	0.14	0.21	0.23	0.21
Average	0.12	0.14	0.16	0.15	0.15	0.17	0.20	0.28	0.28
Percentage of Readings Exceeding the Provincial Guideline[4]	1.4	0.0	0.0	0.0	0.0	0.0	0.0	n.d.	n.d.

[1] March - December
[2] n.d. = no data
[3] i.d. = insufficient data
[4] At least 90 percent of the readings during a month shall be less than 1.0 COH.

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

In Calgary, there used to be six stations for the measurement of soiling index. It is now monitored at the three permanent urban stations. Since 1973, the annual mean has ranged from 0.18 to 0.28 COH units (Table B-18). The soiling index for Calgary is usually higher than for Edmonton. Whereas there appears to be a general increase in the annual means for Calgary, the increase is less pronounced than that for Edmonton.

TABLE B-18. Soiling Index - Calgary

					Annual Means				
	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981[1]
					(coefficient of haze (COH) units)				
Station 1	0.21	0.32	0.16	0.16	0.19	0.24	0.25	0.32	0.40
Station 2	0.24	0.33	0.33	0.34	0.41	0.36	0.43	n.d.[2]	n.d.
Station 3	0.12	0.14	0.10	0.05	0.07	0.15	0.23	n.d.	n.d.
Station 4	0.18	0.22	0.20	0.24	0.25	0.16	0.23	n.d.	n.d.
Station 5	0.22	0.26	0.24	0.23	0.21	0.21	0.26	0.30	0.32
Station 6	n.d.	0.20	0.19	0.09	0.12	0.09	0.11	0.11	0.14
Average	0.19	0.25	0.20	0.19	0.21	0.20	0.25	0.24	0.29
Percentage of Readings Exceeding the Provincial Guideline[3]	10.4	10.6	4.2	1.4	9.7	4.2	5.6	n.d.	11.1

[1] March - December

[2] n.d. = no data

[3] At least 90 percent of the readings during a month shall be less than 1.0 COH.

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

There is no legislated regulation for the soiling index, but a guideline does exist; a minimum of 90 percent of the readings per month shall be less than 1.0 COH unit. This guideline has not been exceeded in Edmonton since 1973. In Calgary, however, the guideline is exceeded regularly.

Other Communities

Both Fort Saskatchewan and Medicine Hat have shown an increase in soiling index between 1976 and 1981 (Table B-4). More comprehensive data are available from Red Deer and Whitecourt (Table B-19). The soiling index in Red Deer remained stable between 1975 and 1978. In 1979, however, a large increase occurred. No significant change in the Whitecourt soiling index is evident.

Dustfall Rate

Edmonton and Calgary

From 1973 to 1981, the Edmonton dustfall network consisted of 24 stations; 15 stations in residential and recreational areas and nine stations in commercial and industrial areas. The annual mean dustfall rate was consistently higher in the latter group (Table B-20). In both groups of stations, there was a gradual increase in dustfall during the past few years.

TABLE B-19. Soiling Index - Red Deer and Whitecourt

Location	Annual Means 1975	 1976	 1977	 1978	 1979	 1980	 Average
	(coefficient of haze (COH) units)						
Red Deer	0.03	0.03	0.04	0.03	0.06	n.d.[1]	0.04
Whitecourt	0.15	0.09	0.09[2]	i.d.[3]	0.12	0.15[2]	0.12

[1] n.d. = no data
[2] 11 months
[3] i.d. = insufficient data

Source: *Unpublished data, Air Quality Control Branch, Pollution Control Branch, Alberta Environment*

TABLE B-20. Dustfall Rate - Edmonton

Land Use Type	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981[1]
	Annual Means (mg/ 100 cm² /30 d)								
Residential/ Recreational	49	46	32	77	52	49	51	65	76
Commercial/ Industrial	94	98	70	112	94	102	140	125	157
	Percentage of Readings Exceeding the Provincial Regulation[2,3]								
	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80	1980-81	1981[1]
Residential/ Recreational	28	30	23	39	42	37	44	54	53
Commercial/ Industrial	26	11	3	10	17	17	26	28	29

[1] March - December
[2] No allowance made for normal background levels
[3] Clean Air (Maximum Levels) Regulation: Residential/ Recreational - 53 mg/ 100 cm^2/ 30 d
Commercial/ Industrial - 158 mg/ 100 cm^2/ 30 d

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

The dustfall network in Calgary consisted of 28 stations during this period; 17 stations in residential and recreational areas and 11 stations in commercial and industrial areas. As in Edmonton, the dustfall rates are higher in the latter group (Table B-21). Up to 1979, there was no significant change in the annual dustfall rates in Calgary. However, the 1980 and 1981 rates show a moderate increase, especially in the commercial and industrial areas.

TABLE B-21. Dustfall Rate - Calgary

Land Use Type	**Annual Means (mg/ 100 cm^2/ 30 d)**								
	1973-74	**1974-75**	**1975-76**	**1976-77**	**1977-78**	**1978-79**	**1979-80**	**1980-81**	**1981[1]**
Residential/ Recreational	63	60	49	60	56	56	58	65	67
Commercial/ Industrial	66	80	63	77	84	63	76	92	96
	Percentage of Readings Exceeding the Provincial Regulation[2,3]								
	1973-74	**1974-75**	**1975-76**	**1976-77**	**1977-78**	**1978-79**	**1979-80**	**1980-81**	**1981[1]**
Residential/ Recreational	39	42	36	42	42	42	46	51	52
Commercial/ Industrial	9	9	2	9	13	5	8	11	6

[1] March - December

[2] No allowance made for normal background levels

[3] Clean Air (Maximum Levels) Regulation: Residential/ Recreational - 53 mg/ 100 cm^2 / 30 d
Commercial/ Industrial - 158 mg/ 100 cm^2/ 30 d

Source: *Air Monitoring Reports, Pollution Control Division, Alberta Environment*

The regulation for dustfall in residential and recreational areas is 53 mg/ 100 cm^2/ 30 d. For commercial and industrial areas it is 158 mg/ 100 cm^2/ 30 d. According to the Clean Air (Maximum Levels) Regulation, allowance must be made for normal background levels when evaluating dustfall rate. In the annual air monitoring reports, however, readings are compared to the regulation without this adjustment. In fact, "normal background levels" have never been established for Alberta (W.S. Macdonald 1983: pers. comm.).

When (unadjusted) dustfall rates are compared with these regulations, contraventions are common in both types of areas (Tables B-20 and B-21). In both cities, approximately 30 to 50 percent of the readings in residential and recreational areas exceed the regulation. Fewer than 30 percent of the readings in commercial and industrial areas exceed the regulation. This is understandable because the maximum permissible concentration for commercial and industrial areas is almost three times that for the other areas.

Other Communities

The annual dustfall rates for several Alberta communities are given in Table B-22. The year-to-year variation is high and consequently no general trend is apparent. High dustfall rates in Coleman and Exshaw may be related to mining activity, whereas high rates in Lethbridge and Brooks are probably a result of wind-borne soil eroded from surrounding farmland.

TABLE B-22. Dustfall Rate in Several Alberta Communities

	Mean Rate ($mg/100\ cm^2/30\ d$)					
Location	1978-79	1979-80	1980-81	1981-82	1982[1]	Average
Blairmore	71.4	86.7	109.7	88.1	95.4	90.3
Brooks	75.0	136.7	117.2	122.3	134.7	117.2
Camrose	31.3	32.1	32.1	38.8	50.6	37.0
Coleman	411.7	294.0	332.4	218.7	234.0	298.2
Exshaw	201.6	153.0	106.6	95.1	97.4	130.7
Fort Saskatchewan	110.2	140.1	77.2	106.0	71.3	101.0
Lethbridge	191.5	158.7	102.0	146.6	78.1	135.4
Medicine Hat	52.5	63.4	43.5	73.9	51.5	57.0
Medicine Hat (Western Co-op Fertilizer)	86.7	96.1	70.0	84.6	74.9	82.5
Red Deer	93.3	97.6	92.4	68.1	43.8	79.0
Sherwood Park	49.4	53.5	65.4	65.9	74.1	61.7
Whitecourt	n.d.[2]	56.1	64.7	56.6	84.0	65.4

[1] March - December
[2] n.d. - no data

Source: *Unpublished data, Air Quality Control Branch, Pollution Control Division, Alberta Environment*

FLUORIDES

In Alberta, fluorides are emitted primarily by fertilizer manufacturing and brick and tile plants. Airborne fluorides can eventually be incorporated into vegetation. High fluoride levels in forage crops can cause serious health problems in grazing animals.

Alberta Environment monitors fluoride levels in the air and vegetation near several industrial sites. This monitoring is performed in addition to the industries' own plant-site monitoring. Mean concentrations from Alberta Environment's fluoride exposure cylinder networks are presented in Table B-23. The highest concentrations were recorded near the Western Co-operative Fertilizers plant in Calgary. The highest reading occurred in April of 1981, when 0.568 $mg/100\ cm^2/30\ d$ was recorded. The provincial guideline (0.040 $mg/100\ cm^2/30\ d$) has been exceeded more than 70 times in this sampling network since 1978. It has been exceeded more than 60 times near the Medicine Hat Brick and Tile plant. Recordings in excess of the guideline have been less numerous at the other monitoring networks. Fluorides in vegetation have not exceeded the guideline level.

TABLE B-23. Fluorides in Several Alberta Communities

Location	**Mean Fluoride Concentration** **1978-79**	**1979-80**	**1980-81**	**1981-82**	**1982[1]**	**Average**
			(mg/100 cm^2/30 d)			
Calgary (Western Co-op Fertilizer)	0.035	0.057	0.070	0.080	0.085	0.065
Carseland	0.003	0.004	0.004	0.008	0.001	0.004
Medicine Hat (New)	0.024	0.033	0.037	0.044	0.014	0.030
Medicine Hat (Western Co-op Fertilizer)	0.021	0.023	0.033	0.035	0.012	0.025
Redwater	0.008	0.011	0.012	0.012	0.007	0.010

[1] March - December

Source: *Unpublished data, Air Quality Control Branch, Pollution Control Division, Alberta Environment*